

## **Historic, Archive Document**

Do not assume content reflects current scientific knowledge, policies, or practices.



Reserve  
aSB762  
.U54  
1997

ted States  
partment of  
iculture

est Service

**Forest Health  
Technology  
Enterprise Team**

Fort Collins,  
Colorado

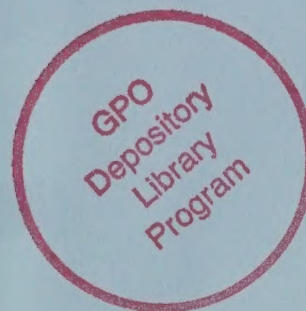
FHTET Report 97-28

November 1997

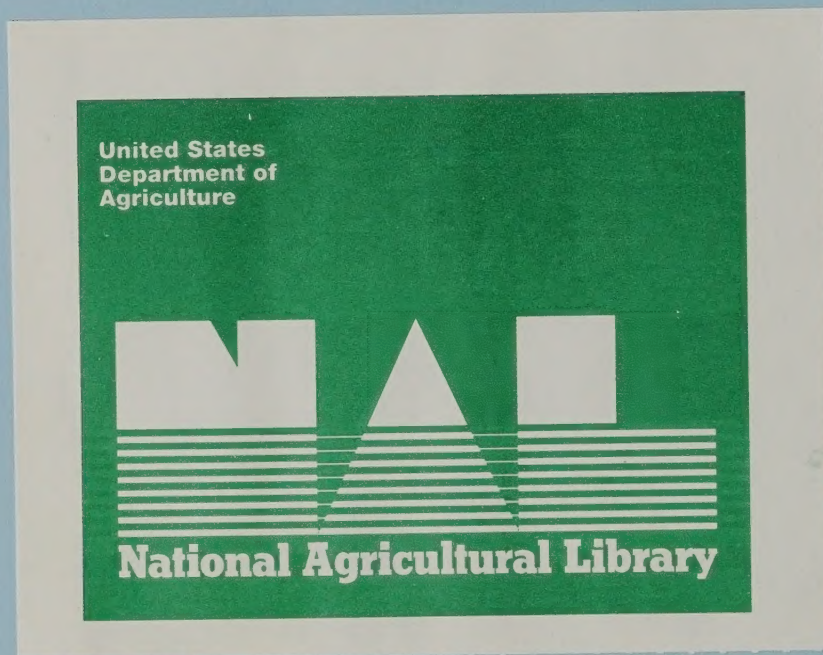


# Forest Health Technology Enterprise Team

## Fiscal Year 1997 Accomplishment Report







The U.S. Department of Agriculture (USDA) prohibits discrimination in its programs on the basis of religion, age, disability, political beliefs, and marital or familial status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (braille, large print, audiotape, etc.) should contact the USDA Office of Communications at (202) 720-2791.

To file a complaint, write the Secretary of Agriculture, U.S. Department of Agriculture, Washington, DC, 20250, or call (202) 720-7237 (voice) or (202) 720-1127 (TDD). USDA is an equal opportunity employer.



## Key FOREST HEALTH TECHNOLOGY ENTERPRISE TEAM Achievements For Fiscal Year 1997

- During the implementation of the 1997 Plan of Work, the Enterprise Team generated over \$1,250,000 in reimbursements, pay-for-service, in-kind, or cooperative dollars.
- Tested new remote sensing technology including: subpixel analysis and a color-infrared digital camera.
- A four year training support project in airborne video and aerial sketchmapping with Anhui Province, China was successfully concluded.
- INFORMS continued its development towards being the key decision support system used within the Forest Service, including:
  - INFORMS has now been installed on most Regions.
  - Version 1.0 was released and a User's Guide published.
  - A review of INFORMS is currently being conducted by the Open Systems Environment Lab and the GIS Center for Excellence for the purpose of national approval.
- Program functions of the Enterprise Team-Davis office have been fully incorporated into other Enterprise Team operations.
- NAPIAP and STDP programs have been successfully transferred to and are now fully administered by the Enterprise Team.
- Web pages have been developed and maintained by the Enterprise Team. These include:
  - Forest Health Protection ([http://162.79.41.7/fh/fh\\_index.html](http://162.79.41.7/fh/fh_index.html))
  - FHTET (<http://162.79.4.71/fhtet>)
  - A website for the Mile-a-Minute weed (<http://troy2.fsl.wvnet.edu/fhpit/mam.htm>)
- Ten cost-reimbursable aerial photography/airborne videography missions were flown in support of FHP Field Staffs, Regional Offices, National Forests, Ranger Districts, and Research, Bureau of Land Management, and Natural Resources Conservation Service units.
- A national GIS database was completed that contains all existing FHP aerial survey data from Regions and Area for 1995 and 1996.
- Two parasites of the mealybug Oracella acuta were released and seemingly established in the field of China as part of an on-going, cost-reimbursable project with the People's Republic of China.
- Pseudoscymnus tusgae, a predator of the exotic hemlock woolly adelgid, is under culture and has been successfully released against this pest. Several additional predator species have been collected and are in laboratory culture and under evaluation for release.
- The Enterprise Team Steering Committee recommends that focus be maintained on developing and delivering new methods and technologies and that we expand our outreach efforts to new groups in order to increase: partnerships, collaborative projects, and cost-reimbursable agreements.

U.S.D.A., NAL

DEC 30 1999

Cataloging Prep



# TABLE OF CONTENTS

INTRODUCTION.....	3
MISSION.....	3
VISION.....	3
GOALS.....	3
ORGANIZATION AND STAFFING.....	4
STEERING COMMITTEE.....	5
PROJECT AREAS.....	6
SUMMARY OF ACCOMPLISHMENTS FOR FISCAL YEAR 1997.....	7
PROJECT ACCOMPLISHMENTS	
I. Management and Operations.....	9
I.1 Management.....	10
I.2 Communications.....	14
I.3 Systems Support.....	15
II. Information Technology and Analysis.....	16
II.1 Data Acquisition.....	17
II.2 Information Analysis and Display.....	23
II.3 Information Management.....	31
II.4 Special Technology Development Program.....	36
II.5 Modeling.....	38
II.6 Quantitative Methods.....	41
II.7 Decision Support Systems.....	47
II.8 Information Distribution.....	51
III. Treatment Technology.....	52
III.1 Decision Support Systems for Pest Control.....	53
III.2 Environmental Fate Studies.....	55
III.3 MTDC Forest Health Program.....	57
III.4 Biopesticides.....	69
III.5 Biological Controls.....	76
III.6 Non-Target Impacts.....	90
III.7 Management of Pesticide Program.....	97
III.8 Management of Pesticides.....	98
APPENDIX A: Acronyms and Abbreviations.....	99
APPENDIX B: Publications.....	100

## INTRODUCTION

Our Nation's forests provide a multitude of resources that can contribute to the economic vitality of local and regional communities while providing clean air and water, wildlife habitat, scenic beauty, and recreational opportunities for millions of Americans. Ensuring ecosystem health, diversity and productivity is a top priority for the USDA Forest Service.

The Forest Health Technology Enterprise Team (FHTET) was established to provide technology needed to protect the health of our nation's forests. The Forest Service plan, entitled "Healthy Forests for America's Future: A Strategic Plan," provides overall goals for developing the technologies required to protect the health of America's forests.

## MISSION

The mission of FHTET is to foster the development and use of technologies to protect and improve the health of America's forests.

## VISION

FHTET is the forest health technology provider of choice because we are:

- responsive to customer needs,
- competent, and
- cost-competitive.

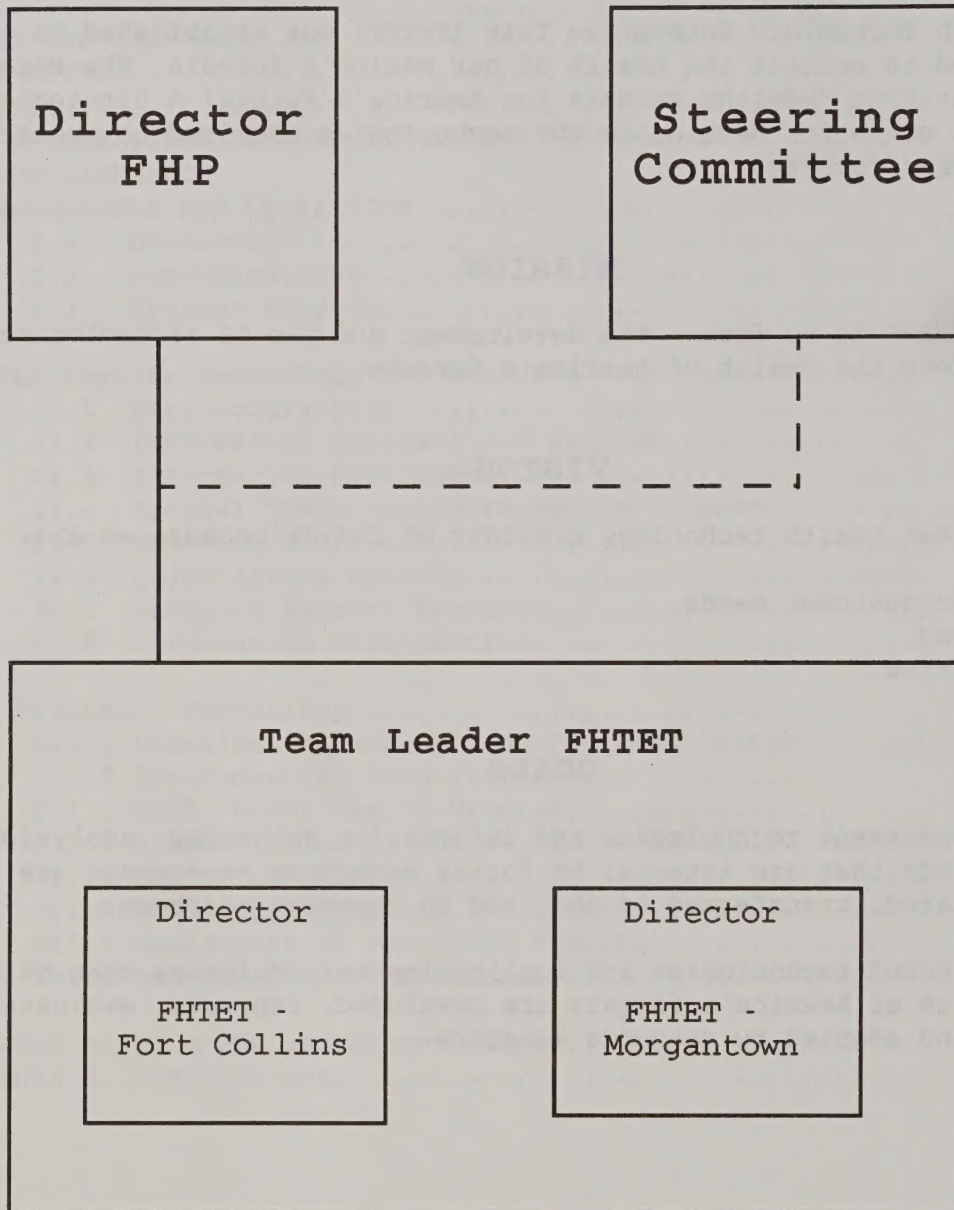
## GOALS

Forest health assessment technologies and information gathering, analysis, and integration methods that are integral to forest ecosystem management are developed, evaluated, transferred to and used by resource managers.

Environmentally sound technologies and application methodologies that maintain or improve the health of America's forests are developed, improved, evaluated, transferred to and adopted by resource managers.



## ORGANIZATION AND STAFFING





## STEERING COMMITTEE MEMBERS

Janet Andersen, Director, Biological Pesticides Division, US Environmental Protection Agency, Washington, DC

Ann Bartuska, Director, Forest Health Protection, USDA Forest Service, Washington, DC

Bill Carothers, Acting Forest Health Team Leader, Region 8, USDA Forest Service, Atlanta, GA

Ernest Delfosse, Director, National Biological Control Institute, USDA Animal and Plant Health Inspection Service, Hyattsville, MD

Bill Dickerson, Director, Plant Industry Division, NC Department of Agriculture, Raleigh, NC

Greg Fitch, Resource Development Bureau Chief, Forestry Division, State of New Mexico, Santa Fe, NM

Wray Freeman, Division Director, Field Operations Support, South Carolina Forestry Commission, Columbia, SC

Christopher Risbrudt, Director, Ecosystem Management Coordination, USDA Forest Service, Washington, DC

Jim Space, Station Director, Pacific Southwest Forest and Range Experiment Station, USDA Forest Service, Berkeley, CA

David Spores, Director, Forest and Rangeland Management, Region 1, USDA Forest Service, Missoula, MT

Tom Thompson, Deputy Regional Forester, Region 2, USDA Forest Service, Denver, CO

John Walstad, Professor and Head, Department of Forest Resources, Oregon State University, Corvallis, OR

## PROJECT AREAS

### I. Management and Operations

Providing FHTET operations at Morgantown, WV and Fort Collins, CO.

### II. Information Technology and Analysis

1. Providing data acquisition technologies such as remote sensing systems and data management systems such as geographic information system (GIS).
2. Providing managers with analytical models and biometrics analysis of forest ecosystem processes involving insects, pathogens, and other disturbance factors; these models can translate the effects of forest management into responses in vegetation-based indicators.
3. Constructing affordable, flexible forest information display tools and to ensure that data visualization will be available and useable in word processing and spreadsheet formats.
4. Developing methods and technologies to identify, measure, and display forest ecosystem values and to systematically relate these values to alternative forest ecosystem management actions and outcomes.
5. Providing forest health information (data, knowledge, and analytical tools) to support the decision-making process for forest ecosystem management.
6. Supporting all management and administrative organizational tasks with publications and transfer of FHTET communication and marketing material to a digital format (Internet, CD).

### III. Treatment Technology

1. Developing easy-to-use field decision support systems, based upon the FSCBG model for managing aerial application projects including: safety buffer zones and predicting levels of control.
2. Developing the capability to predict and account for the fate of control agents (active and nonactive components) in the air, canopy, and ground following aerial application.
3. Developing methods and technologies for the use of biological agents for control of forest pest epidemics, and developing methods and technologies for the use of natural enemies to maintain forest pests below damaging thresholds.
4. Developing information on the effect of control agents on non-target species.



## SUMMARY OF ACCOMPLISHMENTS FOR FISCAL YEAR 1997

Following are samples of the accomplishments from each Project Area.

### I. Management and Operations

- Implemented the Davis, CA office closure plan.
- Conducted the FHTET Steering Committee meeting in Pittsburgh, PA.
- Reviewed the national Special Technologies Development Program.

### II. Information Technology and Analysis

- Completed final draft of the insect and disease national risk map for the Washington Office Risk Map Team.
- Supplied aerial photography and airborne videography services on a cost- reimbursable basis supporting forest health programs.
- Published the PTIPS/AllVeg User's Guide.
- Administered funding for 22 projects being conducted under the Special Technology Development Program.
- Created software to display in ArcView the results generated by the Westwide Pine Beetle Model.
- Conducted a biometric analysis of hardwood tree health for the state of Vermont.
- Released version 1.0 of INFORMS and published the User's Guide.
- Maintained three web pages; FHTET, Forest Health, and Forest Service sites in Fort Collins, CO.

### III. Treatment Technology

- Published papers, journal articles, and reports that enhanced the Enterprise Team's visibility and credibility. For example: *Using Mating Disruption to Manage Gypsy Moth: A Review*.
- Conducted evaluation of standard formulation of Gypchek and modified strain of Gypchek using ground application equipment.
- Natural enemies of the Mile-a-Minute weed were collected and associated damage was recorded for plots in Maryland, Pennsylvania, Delaware, and Virginia.
- Collected baseline population information on the distribution, abundance, physiology, and productivity of over 550 species of arthropods (herbivores, predators, and parasites), 100 species in an eastern, broadleaved forest of spiders, four species of amphibians, and five species of birds in an effort to determine the potential long-term impacts of selected insecticides.

- Improved coordination and understanding of FS-NAPIAP with USDA and university colleagues through presentations to national and regional USDA-NAPIAP meetings.



Project Area I. Management and Operations

**Project:** I.1.a FHTET Implementation

**Project Leader:** Eav

**Objective:** To complete implementation of the Forest Health Technology Enterprise Team

**Cooperators:**

WO-FHP Staff and FHP Regional Directors

**Accomplishments:**

The highlights of the FY97 accomplishments include the successful FHTET Steering Committee meeting held in June 1997 in Pittsburgh, PA, and the smooth functioning of FHTET.

The Steering Committee reviewed FHTET's leadership vacancies and recommended that FHTET rebuild its remote sensing skill base and augment it with added expertise in GIS. In following up on an earlier Steering Committee recommendation, FHTET presented a summary of key communications and marketing activities. The committee reviewed and approved of these activities. The committee encouraged FHTET to continue fostering dialog with current and potential users of products and services, to increase FHTET's exposure to new groups, to increase partnerships for collaborative projects, and to encourage cost-reimbursable agreements for products and services. Other key recommendations include:

- Reach beyond "traditional clients".
- Accelerate movement of all materials to digital media (Internet, CDs) for access and distribution.
- Stay true to a technical audience.
- Integrate communications throughout all aspects of project work.

As a way of better staying in-touch with the challenges of natural resource management, the committee also advised FHTET to focus on development and deployment of new technologies and new methods responsive to its mission rather than undertake to support and maintain systems developed by others .

FHTET leadership is implementing these recommendations.

**Final Product and Due Date:**

FHTET FY97 Program of Work:	January 1997
FHTET Strategic Plan:	December 1997
Steering Committee Meeting:	June 1997



**Project:** I.1.b FHTET-FC Operations

**Project Leader:** Eav

**Objective:** To ensure the effective and efficient operation of FHTET-FC.

**Accomplishments:**

Through teamwork of the entire Forest Health Technology Enterprise Team and in cooperation with FHP WO and field staff, over 95% of projects in FHTET-FC FY97 Program of Work were completed.

At FHTET's annual meeting, personnel from both FHTET-FC and FHTET-M joined with cooperators from the Remote Sensing Applications Center (RSAC) and the Missoula Technology and Development Center (MTDC) to review accomplishments and lessons learned. The information gathered will provide a valuable insight on how to exceed the expectations of future collaborative projects.

Technology needs and priorities were identified by national steering committees representing Regions and Area offices and State cooperators. These needs and priorities were incorporated into the Program of Work.

**Final Product and Due Date:**

FHTET-FC Accomplishment Report for FY96:

November 1996

**Project:** I.1.c FHTET-Morgantown Operations

**Project Leader:** Bullard

**Objectives:** To define and maintain FHTET-Morgantown operations.

**Cooperators:** FHP-WO Director and Staff; FHP Regional/Area Directors

**Accomplishments:**

The Davis FHTET Office closure plan was implemented with four continuing pesticide application and environmental fate studies initiated by the Davis Office shifting to Morgantown. Other major accomplishments include: participation in a review of the national STDP program which resulted in significant changes in the implementation of that program; conduct of an interdisciplinary review of the Butler long-term, non-target impact study; Morgantown staff invited to serve on the USDA Biological Control Steering Committee and the subsequent USDA Biological Control Coordinating Council; successful incorporation of NAPIAP, IR-4, and pesticide registration/reregistration programs into the Morgantown Office; arranged the continuation of the detail of Gary Smith (R-6 Integrated Pest Management Specialist) to coordinate the FS NAPIAP Program through FY99; the office printed and distributed 5 numbered publications, reporting results of FHTET-M-sponsored projects.

Coordination with Region/Area FHP staffs and directors was continued with the goal of discussing FHTET roles and responsibilities as well as FHTET activities within the Regions/Area and opportunities for future cooperation and collaboration. Visits were made to many sites to evaluate on-going, Morgantown-sponsored projects. Planning visits of note by the staff were made to: Brazil, to assess future involvement in the Sirex project; the People's Republic of China, at the request and with the support of FS International Forestry, to discuss future biological control needs and opportunities between the United States and the People's Republic of China.

**Final Products and Delivery Dates:**

1996 FHTET Accomplishment Report:	November 1996
1997 FHTET Program of Work:	January 1997
FHTET-M input into FY 97 Accomplishment Report:	September 1997
FHTET-M input into FY 98 Program of Work:	September 1997



**Project:** I.1.1.d FHTET-Davis Closure

**Project Leader:** Barry

**Cooperators:**

Ann Bartuska  
USDA-FS, WO-FHP

Bov Eav  
USDA-FS, FHTET-FC

Allan Bullard  
USDA-FS, FHTET-M

**Accomplishments:**

The FHTET-Davis office was officially closed on February 28, 1997. An action Plan and Schedule were prepared in August 1996 outlining the closing of the Davis office. Application technology, environmental fate, and biocontrol projects have been transferred to the FHTET-Morgantown office. Model and Decision Support System projects have been transferred to the FHTET-Fort Collins office. Responsibility for management of the FSCBG aerial spray model has been split between Bov Eav, Director, FHTET and Harold Thistle, Missoula Technology Development Center (MTDC) with Bov Eav serving as contracting officer's representative for the FSCBG contract with Continuum Dynamics, Inc. A FHTET-Davis program hand-off meeting was held at Davis, CA in January 1997. All personnel actions have been completed and all accountable property items, files, and reports have been transferred to either FHTET-Fort Collins or MTDC.

**Future Products and Delivery Dates:**

Not applicable.

**Project:** I.2.a FHTET Communications

**Project Leader:** Janiga

**Objective:** To sustain a communications program that fosters cooperative and cost-reimbursable projects. These projects enable the Enterprise Team to maximize opportunities that improve the cost-effectiveness and efficacy of programs designed to improve and protect the health of America's forests.

**Cooperators:**

**Accomplishments:**

The Enterprise Team maintains a communications plan as the backbone for setting the objectives of communications activities. Tasks under this project are primarily an aggregation of tasks assigned to several teams. Production and dissemination of materials is coordinated across all FHTET sites and project teams, including preparation of materials for dissemination through electronic networks.

**Final Products and Delivery Dates:**

- |   |                |
|---|----------------|
| 1. Revised FHTET Communications Plan                            | September 1997 |
| 2. Forest Health Technology Enterprise Team Updates             | quarterly      |
| 3. FHTET display--maintenance and presentation                  | July 1997      |
| 4. FHTET personnel roster design for each facility              | August 1997    |
| 5. Customer Outreach Plan                                       | July 1997      |
| 5. FHTET annual meeting agenda and support materials            | July 1997      |
| 6. FHTET promotional brochure                                   | June 1997      |
| 7. Draft of FHTET capability descriptions for each program area | August 1997    |



**Project: I.3.a Computer Systems Support**

**Project Leader:** Roschke

**Objective:** Provide systems support for FHTET-FC computer equipment and local area network, including maintaining and providing support for IBM contract equipment, other workstations, Macintoshes, PCs, printers, backups, and hardware and software tracking, purchasing, and updating.

**Cooperators:**

Jim McCallum  
Computer Specialist  
Rocky Mountain Experiment Station

Jayne Handley  
Branch Chief  
Information Resources Management  
Washington Office, Forest Service

**Accomplishments:**

The systems support team provided support for all systems in use at the FHTET-FC site, IRM planning support for all of FHTET and FHP, and assisted in supporting personal computers in use in the Washington Office Forest Health Protection staff. Most contractors and federal personnel in Fort Collins completed training in 615 software and are actively transitioning their work to the 615 server. Filing systems were organized for the staff so movement of documents and activity records will be feasible in fiscal year 1998.

**Final Products and Delivery Dates:**

- |   |                |
|---|----------------|
| 1. Access to the IBM system for all FHTET-FC federal and contract staff.  | September 1997 |
| 2. FHTET staff file system established.   | March 1997     |
| 3. FHP Information Resources Management Plan for Fiscal year 1998 submitted to agency Chief Information Officer | April 1998     |
| 4. Year 2000 Assessment Project information exchange established with office for Information Resources Planning | September 1997 |

Project Area II. Information Technology  
and Analysis

**Project:** II.1.a Airborne/Spaceborne Sensor Evaluation and Development

**Project Leader:** Pywell

**Objectives:** In cooperation with Regions/Area and the Remote Sensing Applications Center (RSAC), evaluate new sensor technologies (such as digital imaging and photographic systems), new satellite systems, digital sketchmapping, GPS, moving-map display systems, and image processing techniques for potential application to forest health detection surveys and monitoring.

**Cooperators:**

Tom Bobbe  
RSAC  
Salt Lake City, UT

Paul Greenfield  
RSAC  
Salt Lake City, UT

Dustin Wittwer  
FHP-R10  
Juneau, AK

Eric Johnson  
FHP-R2  
Lakewood, CO

Andy Knapp  
FHP-R4  
Boise, ID

Steve Munson  
FHP-R4  
Ogden, UT

Lisa Levien  
FHP-R5  
Sacramento, CA

Richard Spriggs  
FHP-R8  
Pineville, LA

John Omer  
FHP-NA  
Morgantown, WV

Bill Frament  
FHP-NA  
Durham, NH

Diane Cote  
Manti-La Sal NF  
Price, UT

Bruce Silvey  
NF in Texas  
Lufkin, TX

Tim McConnell  
FHP-R1  
Missoula, MT

Harold Thistle  
MTDC  
Missoula, MT

Dave Bridgewater  
FHP-R6  
Portland, OR

Gordon Hosking  
Forest Research Institute  
Rotorua, New Zealand

**Accomplishments:**

Field testing of the Kodak color-infrared digital camera was continued this field season in Region 8 (Texas), Region 10 (Alaska), Northeastern Area (Vermont), and New Zealand. The camera was developed through a cooperative effort between RSAC and Kodak. Field units are finding that the camera is a useful tool for some aerial survey and remote sensing applications. A draft evaluation report has been prepared in cooperation with the field users. A final report will be available for distribution in early FY98.

Subpixel analysis is a relatively new image processing technique that has shown some potential to detect changes over time in forest condition. With increased demands for detection monitoring in wilderness and other areas that are not routinely surveyed, we are searching for cost-effective methods for monitoring forest change. The purpose of this study was to evaluate a new image processing technique which has potential to distinguish small dispersed stands of forest mortality. The Manti-La Sal National Forest was chosen because it has been experiencing a large outbreak of spruce beetle,



but salvage operations had not yet begun. There was also considerable field data available on the outbreak, which was valuable in assessing the success of the image processing work. LANDSAT TM imagery from August 1985, July 1988, and July 1993 was acquired, as was aerial photography taken in September 1991. Field data from 1994 and 1996 was also available. Image processing work was completed in FY96 and reviewed at a meeting of RSAC, FHTET, Region 4 Forest Health, Region 5 Forest Health, and Manti-La Sal National Forest representatives in August 1996. Field reviews were conducted by RSAC, FHP Region 4, and Forest personnel in the fall of 1996. The final report has been produced and reviewed. It will be available for distribution in early FY98.

An evaluation of electronic moving-map displays for potential use by aerial survey personnel is continuing. The evaluation is a cooperative effort between the Regions, RSAC, MTDC, FHTET and field units. Several off-the-shelf software packages have been evaluated. RSAC worked with GeoFocus to develop additional capabilities and modifications to their existing software to meet FHP aerial sketchmapping needs. Flight testing of this and other systems, scheduled for this summer, have been delayed due to difficulties in getting technical approval for the computer equipment. The equipment, including a PC and a LCD touch panel high-bright screen suitable for use in sunlight, has now arrived. We plan to conduct flight tests this fall.

Several enhancements were made to the DigCam software at the request of FHP users. The DigCam software, developed by RSAC, is used to prepare mission plans, operate the digital camera, and prepare GIS flight line maps.

A market survey of existing commercial GPS flight following systems with potential to assist FHP aerial survey personnel, was completed by RSAC. A plan for a pilot project was developed, however, the project is on hold until participation and financial support from F&AM and NFS can be solicited.

Work continued on the Airborne Video Toolkit (AVT) software for mosaicking video imagery. Through field tests conducted this year in Region 8 and the Northeastern Area, several problems were identified and fixed. A User's Manual for both the hardware and software have been completed. During FY97, we modified the software to allow for the use of Digital Elevation Models. The DEMs improve the accuracy of the resulting mosaics by providing some correction for relief displacement. A plan has been developed by FHTET and RSAC for adapting the AVT for use with images collected using the Kodak CIR digital camera and for incorporating an autocorrelation capability into the AVT. This work will be initiated in early FY98 and will provide the capability to produce better-looking mosaics and to produce mosaics from CIR digital camera images. Funding for this work has come from NFS and other S&PF sources.

Status updates on digital video technology and new satellite systems were written in cooperation with RSAC and distributed to the field via the DG FHP remote sensing/GIS mailing list .

Aerial surveys to test firmware upgrades to the Kodak CIR digital camera and to evaluate digital video systems were completed by RSAC and FHTET on the

Manti-LaSal National Forest. A technical paper "Evaluation of CIR Digital Camera for Forest Health Protection Applciations in Western US and Brazil" was prepared by Andy Knapp (FHP-R4) and Mike Hoppus (RSAC) for presentation at the North American Symposium on Small Format Aerial Photograph.

**Final Products and Delivery Dates:**

Digital CIR image acquisition	August 1997
Image interpretation	October 1997
Evaluation report for CIR digital camera (delayed)	December 1997
Status report (digital video and new satelllites)	June 1997
Digital sketchmapping report	Delayed
Improved automosaic capability	September 1997
Subpixel analysis report (Draft)	May 1997
Subpixel analysis report (Final)	December 1997

**Project:** II.1.1.b Remote Sensing Support for Acquisition of Imagery

**Project Leader:** Myhre

**Objectives:** Provide services and support to the field for acquisition of remotely sensed data in support of forest health monitoring programs and other resource activities. The Remote Sensing Services Teams (RSST), FHTET-Ft. Collins will maintain a program of remote sensing acquisition and support utilizing the FS Beechcraft King Air, plus provide an aerial platform for developmental/test flights for evaluation of new sensor technologies.

The Remote Sensing Applications Center (RSAC) will provide support to acquire satellite imagery, high-altitude aerial photography (9x9, large format camera, or optical bar) and other airborne digital imagery as needed by FHP staffs. High-altitude aerial photography and digital imagery will be acquired through Forest Service participation with the NASA ER-2 High Altitude Program. Other sources for airborne imagery, such as DoE, DoD, other agencies, and private companies will be utilized as needed to support special project needs.

**Cooperators:**

Tom Bobbe	Paul Greenfield	Tom Landon
RSAC	RSAC	Aviation Management-R2
Salt Lake City, UT	Salt Lake City, UT	Denver, CO
Bill Snyder	Fiscal Staff	
Aviation Management-R2	Rocky Mountain Station	
Denver, CO	Fort Collins, CO	

**Accomplishments:**

This service/support activity is operated on a cost-reimbursable basis by the Remote Sensing Services Team (RSST). RSST worked with customers/users requesting support to determine their needs, provide remote sensing consultation, and design an airborne mission plan for acquisition of aerial photography or airborne videography. This program provided a total service package, which included mission planning and cost estimation, preparation of flight maps, acquisition of imagery, purchasing and processing of film, and delivery of end products.

Ten remote sensing missions were flown during FY97 for a variety of Forest Service units (FHP field units, Regional Office, National Forests, Ranger Districts, and Research), and other federal agencies (Bureau of Land Management and Natural Resource Conservation Service).

**Final Products and Delivery Dates:**

Image acquisition missions complete	September 1997
Photo/video products delivered to customers	October 1997



**Project:** II.1.c Remote Sensing Technology Transfer, Training, and Support

**Project Leader:** Myhre

**Objectives:** Provide a series of training courses and technology transfer activities on remote sensing technologies to FHP personnel. These training courses will be designed to improve current operational techniques and to enhance job skills of field personnel. Provide technical assistance and support to FHP field units.

**Cooperators:**

Jule Caylor RSAC Salt Lake City, UT	Paul Greenfield RSAC Salt Lake City, UT	Tim McConnell FHP-R1 Missoula, MT
Lisa Levien FHP-R5 Sacramento, CA	Andy Knapp FHP-R4 Boise, ID	Bill Frament FHP-NA Durham, NH
Julie Weatherby FHP-R4 Boise, ID	Dave Bridgwater FHP-R6 Portland, OR	Chuck Dull ENG-WO Washington, DC
Harold Thistle MTDC Missoula, MT	Larry Stipe FHP-R1 Missoula, MT	

**Accomplishments:**

Preparation of course materials for "Integrating Remote Sensing into Operational Pest Detection and Monitoring Programs" was completed. However, due to schedule conflicts for both instructors and many students, the course has been rescheduled for February 1998.

A one week aerial photography interpretation course was conducted by RSAC at the request of Northeastern Area FHP personnel.

**Final Products and Delivery Dates:**

Preparation of course materials	September 1997
Delivery of FHP PI training in Northeastern Area	December 1997
"Integrating Remote Sensing into Operational Pest Detection and Monitoring Programs"	February 1998

**Project:** II.1.d DFTM Trap Manufacture & Distribution

**Project Leader:** Sally Scrivner

**Objectives:** To coordinate the manufacture and distribution of pheromone traps to western Regions and State cooperators in support of the Douglas-fir tussock moth early warning detection system.

**Cooperators:**

Sandy Kegley  
USDA-FS, R-1  
Coeur d'Alene, ID

Bill Schaupp  
USDA-FS, R2  
Lakewood, CO

Jill Wilson  
USDA-FS, R3  
Flagstaff, AZ

Julie Weatherby  
USDA-FS, R4  
Boise, ID

John Wenz  
USDA-FS, R5  
Sonora, CA

Suzanne Wiley  
USDA-FS, R6  
Portland, OR

**Accomplishments:**

Using the Foothills Gateway Rehabilitation Center in Fort Collins, Colorado to manufacture the traps not only benefits the Forest Service, but contributes to the well being of impaired individuals and the community by providing jobs for this nonprofit center.

**Final Product and Completion Date:**

6500 traps sent to the field:

June 1997

**Project: II.2.a Support for National Reporting Requirements**

**Project Leader:** Pywell

**Objectives:** Provide database development and data management support to the FHP-WO, including: requesting data from field units; data entry, verification and summary; map preparation; and data analysis and interpretation to meet national reporting requirements on forest health conditions, trends, and management.

**Cooperators:**

Ann Bartuska  
FHP  
Washington, DC

Joe Lewis  
FHP  
Washington, DC

Mel Weiss  
FHP  
Washington, DC

Henry Lachowski  
RSAC  
Salt Lake City, UT

Julie Weatherby  
FHP-R4  
Ogden, UT

Noel Schneeberger  
FHP-NA  
Radnor, PA

Ken Gibson  
FHP-R1  
Missoula, MT

Susan Johnson  
FHP-R2  
Denver, CO

Jill Wilson  
FHP-R3  
Flagstaff, AZ

Kathy Matthews  
FHP-R10  
Anchorage, AK

Lisa Levien  
FHP-R5  
Sacramento, CA

Julie Johnson  
FHP-R6  
Portland, OR

Dan Brown  
FHP-R8  
Atlanta, GA

**Accomplishments:**

Support was provided to the Insect and Disease Risk Map Team in the development of a national map and database of insect and disease risk, to the Director in the development of a map and database showing FHP activities on non-Forest Service-administered federal lands, and to the Director in the preparation of maps for the 1996 Insect and Disease Conditions Report. Other planned projects were delayed until FY98 due to the amount of time spent on other activities.

The insect and disease national risk map, being done for the Washington Office Insect and Disease Risk Map Team (Joe Lewis), has been completed. Final draft maps have been reviewed by Joe Lewis and will be reviewed by Regional Team Members at a meeting to be held this fall. At that time, whatever revisions that need to be done will be completed and final maps produced.

An FY97 version of the map of FHP activities on other federal lands has begun. Activities data has been received from all Regions/Area and map preparation is underway. This product should be available for review in October.



Maps showing insect and disease occurrence for the 1996 Insect and Disease Conditions Report have been completed. In most cases these maps were produced using digital data supplied by the Regions. Use of digital data resulted in a significant time and cost savings for both the Regions and FHTET in producing the maps.

**Final Products and Delivery Dates:**

Map of FHP activities on other federal lands	October 1997
I&D national risk map (final draft)	August 1997
Map of suppression, prevention and eradication projects	delayed to FY98
Map of exotic forest insects and diseases	delayed to FY98
Map of air pollution effects	delayed to FY98

**Project: II.2.b Support for Off-Plot Forest Health Monitoring**

**Project Leader:** Pywell

**Objectives:** Provide database development and data management support to the FHP-WO for Forest Health Monitoring, including requesting data from field units; data entry, verification and summary; map preparation; and data analysis and interpretation to meet national reporting requirements on forest health conditions and trends.

**Cooperators:**

Rob Mangold FHP Washington, DC	Bob Loomis FHM RTP, NC	Sally Campbell FHP-R6 Portland, OR
Joy Roberts FHP-R4 Boise, ID	Dick Halsey FHP-R4 Boise, ID	Margaret Miller-Weeks FHP-NA Durham, NH
Larry Stipe FHP-R1 Missoula, MT	Susan Johnson FHP-R2 Denver, CO	Terry Rogers FHP-R3 Albuquerque, NM
Kathy Matthews FHP-R10 Anchorage, AK	Lisa Levien FHP-R5 Sacramento, CA	Julie Johnson FHP-R6 Portland, OR
Susan DeLost FHP-NA Morgantown, WV	Bill Schaupp FHP-R2 Lakewood, CO	Ed Yockey FHP-R8 Ashville, NC

**Accomplishments:**

In early FY97, a national GIS database was completed that contained all existing FHP aerial survey data available from the Regions/Area for 1995. An analysis of this data was completed to identify differences between Regional approaches to aerial surveying. The results of this analysis were presented at the Forest Health Monitoring Workshop held in Dallas in January 1997 and again at the FHP Directors Meeting in San Antonio in February 1997. Based on discussion at those meetings and at an earlier meeting of FHP GIS and aerial survey personnel, it was decided that a work group would be formed to address aerial survey standards data standards. Work towards those standards will continue in FY98.

1996 data has now been added to the database. These data will provide further information for the aerial survey standards work group meeting to be held in early FY98.

**Final Product and Delivery Dates:**

Database for all Regions of 1995 aerial survey data	December 1996
GIS/Aerial Survey Meeting	November 1996

Report on inter-Regional differences (FHM Dallas meeting)	January 1997
Report on inter-Regional differences (Directors meeting)	February 1997
R4 Pilot Test	delayed
Database 1996 aerial survey data for all Regions	October 1997
Recommendations on data collection and coding standards	Ongoing



**Project:** II.2.c GIS/Remote Sensing/Data Visualization Application Support

**Project Leader:** Pywell

**Objectives:** Through the facilities of the Advanced Technology Lab, provide training, support and leadership to FHTET, FHP field units, and domestic and international cooperators in the evaluation, use, and application of remote sensing, image processing, data visualization, and GIS technologies. Act as GIS Coordinator for the Washington Office Detached Units in Fort Collins.

**Cooperators:**

Richard Spriggs  
FHP-R8  
Pineville, LA

John Knighten  
FHP-R8  
Asheville, NC

Andy Knapp  
FHP-R4  
Boise, ID

Brian Orland  
Univ. of Illinois  
Champaign, IL

Ann Lynch  
RMS  
Flagstaff, AZ

Helen Maffei  
FHP-R6  
Bend, OR

Burhanuddin Sarbini  
Ministry of Forestry  
Jakarta, Indonesia

Carl Sumpter  
Medicine Bow NF  
Laramie, WY

Bill Frament  
FHP-NA  
Durham, NH

Jian Wu  
Chinese Academy of  
Forestry  
Beijing, PRC

Mok Mareth  
Ministry of Environment  
Phnom Penh, Cambodia

Zhou Jian Sheng  
Anhui Forest Biological  
Control Center  
Hefei, PRC

Jim Ellenwood  
Kaibab NF  
Williams, AZ

**Accomplishments:**

Assistance was provided to FHP Region 8 (Pineville and Asheville Field Offices) and Northeastern Area (Durham Field Office) in the use of the new video automosaicking equipment and software.

In cooperation with Research, FHTET is providing assistance in the implementation of airborne videography in Indonesia. Training of Indonesian personnel was conducted in December 1996.

Training was provided to FHP Region 10 in the use of the Kodak CIR digital camera.

A brochure describing data visualization technology and several applications was reprinted because of high demand.

Training in remote sensing and GIS was provided to personnel from the Anhui Biological Control Center of Anhui Province, People's Republic of China. Training included on-site training in airborne video image acquisition and image processing in Hefei, PRC, training in the use of the Kodak CIR digital

camera conducted in both China and the U.S., and 4 weeks of GIS training provided to 2 individuals in FHTET's lab in Fort Collins.

Provided a technical briefing on FHTET's remote sensing and GIS activities to the Minister of Environment for the Kingdom of Cambodia and to a representative from USAID. Following the briefing, the FHTET Director traveled to Cambodia to assist in formulating a plan to strengthen Cambodia's remote sensing and GIS capabilities for use in detecting and monitoring timber theft from conservation lands in Cambodia.

FHTET continued to maintain and support the Fort Collins GPS community base-station in cooperation with Region 2. The base-station and associated computer bulletin board provides GPS correction files for Forest Service and other users within a 300-mile radius of Fort Collins.

**Final Products and Delivery Dates:**

R8 and NA automosaic technical assistance	August 1997
Indonesia airborne video training	December 1996
R10 CIR digital camera training	July 1997
China remote sensing and GIS training	July 1997
Cambodia remote sensing/GIS technical assistance	September 1997
GPS base station support	September 1997

**Project:** II.2.d Pest Model Output Display

**Project Leader:** Pywell

**Objectives:** In cooperation with FHP Regions, Timber Management Service Center, Intermountain Station, Missoula Fire Lab, the Universities of Arizona and Illinois, and Texas A&M University, continue development of a visual output component for forest insect and disease models which will allow the display of pest impacts, forest fuels, and forest management alternatives, and develop an interface of these capabilities to ARCVIEW, INFORMS, and the Forest Vegetation Simulator (FVS).

**Cooperators:**

Brian Orland  
Univ. of Illinois  
Champagne, IL

John Wells  
Timber Management  
Washington, DC

Tommy Gregg  
FHP-R6  
Portland, OR

Bob McGaughey  
PNW  
Seattle, WA

Nick Crookston  
INT  
Moscow, ID

Terry Daniel  
University of Arizona  
Tucson, AZ

Steve Munson  
FHP-R4  
Ogden, UT

Brian Ferguson  
Dixie National Forest  
Cedar City, UT

**Accomplishments:**

Continued support to the SmartForest installation on the Dixie National Forest.

Because the OpenGL graphics library is not supportable on the x-terminal configurations delivered under Project 615, SmartForest was recompiled with the MESA graphics library, providing most OpenGL functions with little performance loss.

SmartForest version 1.4 was installed at FHTET and on the Dixie National Forest. Version 1.4 contains a number of enhancements including: the user can color ground surface by stand; the user can query stand and tree data by point-and-click; color trees by dbh, height and species; and the user can color/texture non-forest features such as roads, meadows, lakes or developed areas, if suitable GIS data exists. A prototype map browser has been developed and implemented. The interface provides the user with the ability to browse stand maps and invoke SmartForest directly from ARCVIEW.

A cooperative agreement with the University of Arizona titled "Human Response-Based Evaluation of Environmental Data Visualization Systems" was completed. This study provides valuable insight into how people view and react to data presented through various data visualization techniques. The final report, complete with all images used in the study, is available on CD through FHTET or can be viewed on the internet at:<http://starr-www2.tamu.edu/dataviz/>



**Final Products and Delivery Dates:**

Implement SmartForest using MESA Graphics	December 1996
Installed SmartForest version 1.4	July 1997
Evaluation of x-terminal environment	March 1997
Dixie evaluation report	Delayed
Integration with ArcView interface	September 1997
Final Report "Human Response-based Evaluation of Environmental Data Visualization Systems"	September 1997

**Project:** II.3.a Support for Forest Health Projects and Display

**Project Leader:** Janiga

**Objectives:** To monitor and report the progress and findings of Western Forest Health Initiative Projects, and to foster dialog about forest health issues through the distribution and display of the Forest Health Issues exhibit.

**Cooperators:**

Regional Forest Health Coordinators

Dave Atkins	Robert Averill	Douglas Parker
Forest Pest Management	Renewable Resources	Forestry
Missoula, MT	Denver, CO	Albuquerque, NM
Jack Amundson	John Neises	Jerry Jensen
Timber Management	Forest Pest Management	Timber Management
Ogden, UT	San Francisco, CA	San Francisco, CA
Margaret Petersen	Jerry Boughton	
Forest Health	Forest Health Management	
Portland, OR	Anchorage, AK	

Washington Office Staff

Ann Bartuska	Mel Weiss	Linda Jones
WO-FHP Director	WO-FHP Deputy Director	WO-FHP Budget Analyst
Washington, DC	Washington, DC	Washington, DC
Leah Clark	Marion Lostrom	David Thomas
WO-FHP Forest Health	WO-Public Affairs Office	WO-FHP Silviculturalist
Communications Manager	Washington, DC	Washington, DC
Washington, DC		

**Accomplishments:**

The Western Forest Health Initiative was started in fiscal year 1995 in order to identify key projects occurring throughout the west that contribute to site restoration, minimize the hazard of loss of ecological processes, and/or restore or substitute for ecological processes. Tracking of project progress is conducted by Forest Health Coordinators with support from the Enterprise Team. Work conducted under this project has provided data acquisition, storage, management, and reporting support for the Western Forest Health Initiative and the coordination for the Forest Health Display. The Enterprise Team coordinated the use of the Forest Health Display. Most conference registrations, booth fees, and similar logistics were managed and paid for in support of national program use of the display. Marion Lostrom, Public Affairs Office, also coordinated the use of the display over a period of several months while it was in the Washington, DC area. A promotional letter was disseminated to all Regional Foresters encouraging use by other Forest Service and State personnel.

**Final Products and Completion Dates:**

1. Databases and data management services for the Western Forest Health Initiative: December 1996
2. Coordination of the Forest Health exhibit for national conferences and other meetings as requested by regional coordinators: October 1996, December 1996, January 1997, March 1997, May 1997



**Project:** II.3.b PTIPS Database Support

**Project Leader:** Adams

**Objectives:** To maintain the PTIPS database for use by Regions, National Forests, and Ranger Districts for generating reports on current and projected forest conditions in order to validate and calibrate pest models.

**Cooperators:**

Sue Hagle  
Nancy Campbell  
R1-FHP  
Missoula, MT

Pete Angwin  
R2-FHP  
Gunnison, CO

Jeri Lyn Harris  
R2-FHP  
Rapid City, SD

Terry Rogers  
R3-FHP  
Albuquerque, NM

Borys Tkacz, PTIPS Mgr.  
Mary Lou Fairweather  
R3-FHP  
Flagstaff, AZ

John Guyon  
R4-FHP  
Ogden, UT

Susan Frankel  
R5-FHP  
San Francisco, CA

Ellen Goheen  
R6-FHP  
Medford, OR

Bruce Hostetler  
R6-FHP  
Gresham, OR

Paul Hennon  
R10-FHP  
Juneau, AK

**Accomplishments:**

The new database structure resultings rom the merger of PTIPS and AllVeg was released in October. To assist users with installing and using the database the user's guide was revised and distributed. A user's meeting was held at the beginning of February to share information concerning installation and system administration issues and proposed solutions. Future needs and conversion to 615 were also topics of discussion.

In January a meeting was held to discuss a proposal for a new database structure. It was agreed that this was a good idea, as long as the design was simple and the budget and time frame were kept to a minimum. Ralph Johnson of the Forest Management Service Center and Eric Twombly of the Ecosystem Management Information Issues Team are coordinating this effort to combine PTIPS/AllVeg and with range data into a single, standard, nationally supported database structure called FSVEG. FSVEG is being developed by Tonya Baggett, from Ralph Johnson's staff, using ORACLE Designer 2000. The data definitions have been completed and are available for review. This will allow for future development, distribution, and support to be coordinated through the Information Resource Management (IRM) staff.

**Final Product and Delivery Date:**

PTIPS/AllVeg release and user's guide October 1997

**Project: II.3.c PURS Database Support and Report**

**Project Leader:** Roschke

**Objective:** Collect and manage pesticide use data from the Regions and Area; prepare the Pesticide Use Report for inclusion in the Annual Report of the Forest Service; transfer the database from a non-contract Sun workstation to the IBM/615 system.

**Cooperators:**

Dave Thomas

Forest Health Protection, WO  
Washington, DC

Paul Mistretta

Forest Health, Southern Region  
Atlanta, GA

**Accomplishments:**

One of the tables included in the annual "Report of the Forest Service" is a summary report of pesticide use on National Forest lands, listing the active ingredients, the target pest or purpose, the quantities used, and the units treated for each pesticide. An Oracle database application has been developed at FHTET-FC and used for the last few years to manage the data and produce the report; its transfer to Oracle on the corporate platform will open the door for increased access to and use of the data by WO-FHP and other FS personnel.

**Final Products and Delivery Dates:**

- |  |                |
|--|----------------|
| 1. Letter to Regions, Area, IITF, and Stations requesting pesticide use information. | September 1996 |
| 2. Fiscal Year 1996 data entered and verified.                                       | January 1997   |
| 3. Pesticide use report for Annual Report of the Forest Service.                     | January 1997   |
| 4. PURS database converted and moved to IBM platform.                                | July 1997      |

**Project:** II.3.d NAPIAP Database Support

**Project Leader:** Adams

**Objectives:** To provide a database for NAPIAP on 615 platform.

**Cooperators:**

Gary Smith  
FHTET (Morgantown detail)  
Portland, OR

**Accomplishments:**

The Financial Management and Information System (FMIS) was reviewed as an optional database structure for the NAPIAP and STDP project data. It was decided that too many modifications to FMIS would be necessary to meet the needs of these two projects. As a solution, a database was designed using the requirements specified from NAPIAP and STDP with the flexibility to accommodate similar future projects.

A prototype was developed using Oracle. A review of the prototype was conducted by the managers of NAPIAP and STDP. A number of changes and suggestions initiated from this review have been incorporated into the database. Data entry will be conducted by the managers as a test for ease of use, completeness, and logical order.

**Final Product and Due Date:**

Draft version of the Project Management Database System (PMDS)



**Project: II.4.a Special Technology Development Program Support**

**Project Leader:** Janiga

**Objectives:** To coordinate the review and administration of the Special Technology Development Program projects; manage operations and planning of the program in manner that adds value and capitalizes on complementary opportunities between this program, the National Pesticide Impact Assessment Program, Forest Health Technology Enterprise Team projects, and related technology development programs within the Department of Agriculture.

**Cooperators:**

Bob Bridges  
Director for Vegetation Management Protection and Research  
Washington, DC

**Region, Area, and IITF Forest Health Directors**

William W. Boettcher	Robert Averill	Milo Larson
Forest Pest Management	Renewable Resources	Forestry
Missoula, MT	Denver, CO	Albuquerque, NM

Dayle Bennett	John Neisess	Max M. Ollieu
Region 4 Representative	Forest Pest Management	Forest Insects&Diseases
Ogden, UT	San Francisco, CA	Portland, OR

Bob Anderson	Jerry Boughton	Gerald D. Hertel
Forest Health	Forest Health Management	Forest Health
Atlanta, GA	Anchorage, AK	Radnor, PA

Robin Morgan  
International Institute of Tropical Forestry  
San Juan, Puerto Rico

**Forest Health Protection Sponsored Steering Committee Chairpersons**

Iral Ragenovich	Dave Thomas	Roger Sandquist
Bark Beetles	Vegetation Management	Seed, Cone and Regeneration Insects

Dave Johnson	Dan Brown	Patrice Janiga
Western Diseases	Eastern Diseases	Modeling, Integrated Systems and Remote Sensing

Jack Barry	Jill Weatherby & Sheri Smith
Spray Application	Co-Chairs Western Defoliators

**Accomplishments:**

Forest Health Protection (FHP) technology development projects enable the FS to continually improve integrated pest management and to better protect forest health. Projects conducted through this program provide a means of evaluating research results and technology efficiency in the context of field operations. Sound management of technology development requires direct involvement of the benefiting or target users of technologies, regular rigorous reviews of technologies and their adaptations, and

leveraging of investments and cooperative opportunities across federal and state agencies. The Special Technology Development Program fulfills these needs for forest health protection technologies.

There previously had been problems with coordinating project needs and proposed development activities across this program, the National Pesticide Impact Assessment Program, and the Interregional-4 Biopesticide program. In fiscal year 1997 the Enterprise Team members responsible for these programs shared information about program activities, priorities, and proposed projects. The Enterprise Team also initiated a database system. This system will provide further monitoring, coordination, and communication of these programs throughout the Enterprise Team and the rest of the agency.

**Final Products and Delivery Dates:**

- |    |  |  |
|----|--|--|
| 1. | STDP requests for proposals, proposal distribution, economic analysis of proposals, and synthesis of review team recommendations for funding allocation:             | September 1996<br>through January 1997 |
| 2. | Updated project report compendium:   | April 1997                             |
| 3. | Coordinate program communications with steering committees and their members, especially to improve general knowledge of and access to project findings and results: | Throughout the year                    |
| 4. | Draft synopsis reports of major accomplishments of the program through the past 8 years and recommendations for future outlook:                                      | August 1997                            |





**Project No.:** II.5.b

**Project Name:** Forest Vegetation Simulator (FVS) Conference Coordination

**Project Leader:** Adams

**Objectives:** To assist the Forest Management Service Center and the Intermountain Research Station in organizing and conducting a conference on the Forest Vegetation Simulator.

**Cooperators:**

Rich Teck  
WO Forest Management Service Center  
Fort Collins, CO

Melinda Moeur  
Northern Rocky Mountain Station  
Moscow, ID

**Accomplishments:**

The first Forest Vegetation Simulator user's conference was held February 4-6, 1997 in Fort Collins, CO. Approximately 100 attendees from different areas and regions within the United States and Canada convened for three days. They shared information and experiences on various projects that have utilized FVS. There were representatives from the Forest Service, private industry, Bureau of Indian Affairs and universities offering positive and negative FVS experiences as well as insight into future development. Attendees were pleased with the conference and the overall feeling expressed was that it was a beneficial session and something similar should be coordinated again in the future.

A conference proceedings is available from the Rocky Mountain Research Station, Ogden, as INT-GTR-373.

**Final Product and Delivery Date:**

Conference proceedings

October 1997

**Project: II.5.c Pest Model Interface Development**

**Project Leader:** Janiga

**Objective:** Provide a graphic interface to pest models (with improved data interchange and analytical capacity) in a manner that supports technology transfer to National Forests, States, and private parties conducting environmental assessments.

**Cooperators:**

Gary Dixon  
Forest Management Service Center  
Fort Collins, CO

Nick Crookston  
Rocky Mountain Experiment Station  
Moscow, ID

**Accomplishments:**

Pest models integrated with the Forest Vegetation Simulation System require a user interface in order for forest and district personnel to efficiently apply the models within their local environmental assessments. In order to fulfill technology transfer responsibilities for the agency, states, and private parties, the design and user documentation for the interface must also enable users to access, exchange data with, and use other applications such as spreadsheets, GIS, and word processors. This integration objective was preliminarily addressed in fiscal year 1997 through the integration of SUPPOSE with INFORMS.

Several groups work on projects closely related and interdependent with pest models. These are the FMSC, EMAC, INT, and PNW. The vegetation simulation, forest planning, and visualization tools being developed by these units are also used by pest model users who have needs to both directly and indirectly apply these tools in conjunction with pest models. The Enterprise Team work conducted in fiscal year 1997 was limited to incorporating pest models into the existing version of SUPPOSE, assisting with training sessions and adaptation of existing training materials used by regional trainers for SUPPOSE training sessions, and devising a basic design for ecologically congruent textual interaction between the user and the system for an initial pest model, the Western Root Disease Model. Much more work will be needed in future years, but much of the system development will be accomplished by the cooperators with a similar level of contribution from the Enterprise Team and assistance with pest models as required.

**Final Products and Delivery Dates:**

1. Pest models incorporated with SUPPOSE: January 1997
2. Initial design for PC-based interface for text-rich ecosystem component modules devised with XVT development software and delivered to primary SUPPOSE developer: July 1997
3. Full system implementation with ecosystem components: September 1999

**Project:** II.6.a Methods to Simulate Landscape Processes

**Project Leader:** E.Smith

**Objective:** Ongoing efforts to solve bio-statistical challenges to adapt and expand insect and disease models to landscape level analyses. Primary areas of FY97 work are: representing stand data for stands which have not been extensively sampled, simulation of contagion events across stands, integration of multiple agent impacts including fire, and expanding model scope to recognize impacts in a disturbance ecology context.

**Cooperators:**

Elizabeth Reinhardt	Rich Teck	Nick Crookston	Tom Gregg
Colin Hardy	Gary Dixon	Melinda Moeur	R-6 FID
RMRS-Fire Lab	For. Mgt Serv Ctr	RMR Station	Portland OR
Missoula, MT	Fort Collins, CO	Moscow, ID	
Werner Kurtz	Kelsey Milner	Brian Giels	R.L. Korol
Julie Greenough	Univ. of Montana	RMR Station	RMR Station
ESSA, Ltd.	Missoula, MT	Flagstaff, AZ	Missoula MT
Vancouver, BC			

**Accomplishments:**

Analyses of approaches to landscape modeling with limited data was performed using Black's Mountain Experimental Forest (CA) data. Most Similar Neighbor and other imputation techniques were evaluated, along with geostatistical and statistical techniques. Landscape scale and grain size effects were analyzed for the Westwide Pine Beetle Model. Software to link WWPB Model with Arcview was completed. Results were presented at three professional meetings and in proceedings. Model modifications are being made based on study results.

Through a cooperative agreement with Dr. Kelsey Milner, University of Montana, we assessed the BGC family of models for their potential integration into current FVS insect and disease modeling system. Capabilities and limitations of each system were considered, and opportunities for integration were specified. Prototype software was written to translate forest stand information for FVS to Stand-BGC. Runs were made which demonstrated the opportunities available from model integration. Documentation of this work is in progress.

Reviewed FS approaches to succession and contagion processes developed by Research with an emphasis on fire models. Continued cooperation and coordination with Research on integration of the FVS Fire Model with insect and disease models. Chaired and presented at a workshop session at WFIWC.

FHTET staff and R-2 FHP, working as members of the ID Team for the Cold Springs Ecosystem Analysis, Medicine Bow NF, completed a landscape level forest health analysis. The project provided FHTET with experience and insight into current District-level needs and processes.



## **Final Products and Delivery Dates:**

### **Westwide Pine Beetle Model:**

Creation of software to display results in Arcview, complete;

Western Pine Beetle software calibration, due 1/98;

WWPB software code debugging, due 12/97;

Analysis scale sensitivity analysis, completed.

BGC Model assessment, documentation due 3/98;

Joint Fire-bark beetle demonstration, schedule determined by cooperator;

### **Cold Springs Area Analysis**

Biological Evaluation, final draft is complete, publication by R-2;

Project EIS, schedule determined by Douglas District.

**Project: II.6.b Biometrics Analysis and Support**

**Project Leader:** E.Smith

**Objective:** To provide biometrics and other quantitative analysis services within FHTET, to field staffs, and other project teams. This analysis ensured the validity of surveys, field tests, and models.

**Cooperators:**

Dave Johnson Bill Schaup R-2 FHP Lakewood, CO	Susan Frankel R-5 FHP San Francisco, CA	Nick Crookston INT Station Moscow, ID	Kathy Sheehan R-6 FID Portland, OR
Jane Taylor R-1 FHP Missoula, MT	Ladd Livingston Idaho Dept. Lands Coeur d'Alene, ID	Rudy King RMR Station Fort Collins, CO	Brian Geils RMR Station Flagstaff, AZ
Ron Kelly Forestry-St of Vt Morrisville, VT	Susan Cox NA Durham, NH	Lia Spiegel WY State Forestry Cheyenne, WY	Mark Schultz R-10 FHP Juneau, AK

**Accomplishments:**

The following consultation and reviews were performed as support to FHP field staffs and to our cooperators:

- Dwarf-mistletoe data analysis for R-1;
- Joint inventory-modeling projects for R-2 NFs;
- Blister rust risk model study for R-3 and RMRS;
- Western gall rust survey design issues for R-4;
- Sensitivity analysis of FVS annosus model for R-5;
- Spatial analysis materials for R-10;
- Training materials developed for Remote Sensing Training Course

The analysis of the third measurement of Vermont hardwood tree health was completed. FHTET had primary responsibility for data analysis. The final draft of the report, co-authored by FHTET, has been reviewed; it will be published by the State of Vermont.

FHTET has cooperated with R-6 and RMRS staffs in the development of a revised Western Spruce Budworm Model. The beta version of the model is complete, we are currently reviewing the model code and documentation. A poster presentation was given at the Western Forest Insect Work Conference and at the FVS Workshop. Also in cooperation with R-6, we have reviewed an insect and disease risk rating systems and stored the information in a database.

FHTET continued to provided representation on the National 615 Statistical Software Committee. The Committee provides input to the WO concerning FS statistics software needs and ways to meet them.

FHTET provided substantial assistance for a forest health evaluation of a project area on the Medicine Bow NF. We had primary responsibility for data analysis and model runs. The results have been reported in an R-2 FHM document co-authored by FHTET and will be a key input in the EIS for this project. We created visual images of stand model results in SVS; these images have been presented at internal and external meetings. FHTET co-authored a forest health evaluation for the Piney Area, White River NF. We also created visual images of stand projections of bark beetle mortality and presented them at an FS public meeting in Vail, CO. Project analysis was also presented at a FVS Workshop and in the proceedings of this workshop.

#### **Final Products and Delivery Dates:**

Annosus Sensitivity Analysis, report completed.  
Vermont survey report: completed, ready for publication by VT.  
Western Spruce Budworm Revised Model:  
    Released model and documentation, schedule determined by R-6.  
Insect and Disease Risk Rating Catalog:  
    Completed database and documentation, due 4/98.  
615 Statistical Software Committee: input will continue as needed.  
Cold Springs Forest Health Assessment:  
    FHP evaluation completed, ready for publication by R-2;  
    ID team input will continue as needed.  
Piney Area Forest Health Assessment:  
    completed and published.  
    follow-up assistance on Vail beetle outbreak as needed.  
Delivery of Remote Sensing Training: scheduled for 2/98.  
Project assistance to Regions: ongoing, as needed.



**Project:** II.6.c Values Determination Project

**Project Leader:** E.Smith

**Objectives:** To review and evaluate methodologies for estimating the economic value of nonmarket goods related to forest health issues and management alternatives; to prepare this information for field use.

**Cooperators:**

John Loomis	George Peterson	Armando Gonzalez-Cabanes
Michele Haefele	RMR Station	PSW Station
Colo State Univ	Fort Collins, CO	Riverside, CA
Fort Collins, CO		
Dave Cleaves	Linda Langner	
WO-EM	WO-RPA	
Washington, DC	Washington, DC	

**Accomplishments:**

Completed review of nonmarket economic impacts of forest insect pests; FHTET authored document published as PSW-GTR-164. FHTET authored journal manuscript of pest and pest management scenic beauty impacts was submitted, and is currently being revised for resubmission. FHTET co-authored manuscript on contingent valuation is currently undergoing journal review.

Completed joint project with FS Riverside Fire Lab reviewing attitude surveys regarding fire and forest pests and their management. Project report has been completed. Portion of results presented at professional meeting and in proceedings.

Completed coop with Colorado State University on project analyses and on development of a potential methodology for eliciting comparative forest health values through a conjoint analysis instrument.

Enterprise Team-funded projects comparing survey instruments was begun, with funding from PSW to continue into FY98. Funding from WO-RPA was secured for FY98 work involving a review of methodologies for the next RPA Assessment.

Finished staffing of the Mexican log import pest risk assessment team, including input to team report.

Consulted and provided information to staff of White River regarding values issues relevant to Vail mountain pine beetle outbreak.

## **Final Products and Delivery Dates:**

Nonmarket economic impacts of forest pests: A literature review published as PSW-GTR-164 (completed).

"Economic valuation with the method of paired comparison and its implications for discrete choice contingent valuation": manuscript undergoing peer review through The American Economic Review, final publication date subject to acceptance and journal schedule.

Mexican log import pest risk assessment report: completed.

"Assessing forest scenic beauty impacts of stand treatments and pests: A review": manuscript is being revised after journal peer review, final publication date subject to acceptance and journal schedule; if not accepted, will be produced as FHTET report by 6/98.

"Public attitudes towards forest health management practices: Knowledge, benefits, and attitudes regarding fire and pests.": results will be produced as PSW research report, journal paper, or FHTET report, due 8/98; preliminary presented in Proceedings of the 26th annual Southern Forest Economics Workshop.

"Forest health value analysis and needs assessment": completed (final report for cooperative agreement #28-CS-892).

**Project:** II.7.a INFORMS Implementation

**Project Leader:** Williams

**Objectives:** Build installation tape, publish supporting documentation, install version 1.0 and train staff on selected sites, fix normal first year software "bugs" and add critical enhancements, and seek approval as a national application.

**Cooperators:**

Forrest Oliveria  
R8 FHP

Eric Twombly  
R6 MS

Ron Perisho  
Ouachita NF, R8

Joe Campbell  
Texas A&M Univ.

Rob Holmes  
Texas A&M Univ.

Susan Gray  
R2 RO

Pat Jackson  
R3 RO

Sue Prece  
R4 RO

Paul Bradford  
EMCT

Jorge Negrón  
R9 RO

**Accomplishments:**

INFORMS version 1.0 was formally released on February 27, 1997 after extensive testing and creation of an install tape. A 160 page User's Guide was published 3/97, and a 100 page Installation Guide was published 5/97. Three test sites were promptly upgraded to version 1.0. By the end of FY97, INFORMS was implemented on 9 additional sites for a total of 12 sites. INFORMS is now implemented on 1 or more sites in every region except Region 3. Feedback from these 12 sites was used in the later half of FY97 to further refine the Installation Guide and to refine version 1.0 in preparation for version 1.1. Version 1.1 is in the final testing stage and will be released in the first half of FY98. During FY97, INFORMS awareness training was provided at the Eastern University, and 2 presentations were made to WO staff. Many more sites than the 12 have asked for INFORMS, but the pace of implementation was purposely restrained in order to further refine implementation procedures before pursuing more widespread implementation. Most existing sites funded travel and labor involved with implementation. INFORMS was installed for review by OSE and the GIS COE as part of the national approval process. Although national approval was not sought or received in FY97, all factors involved with this process were addressed; approval should be achieved in FY98. Demand is very high for the software and the Ecosystem Management staff may help fund/champion widespread implementation in FY98.



# **Final Products and Delivery Dates:**

Version 1.0 of INFORMS	released 2/27/97
User Manual	published 3/97
Installation Guide	published 5/97
System operational on 12 sites	9/30/97
Eastern University training	completed 2/97
Maintenance for 615 platform accomplished	Ongoing
(keep system functional after 615 system changes such as upgrade to ArcView 3.0).	

**Project:** II.7.b Integration of Forest Health Tools within INFORMS

**Project Leader:** Williams

**Objectives:** Integrate SUPPOSE within INFORMS, integrate other forest health tools, consult on development of the Rulebase Toolkit and use of rulebases, and assist with partner funded efforts to integrate other analytical tools.

**Cooperators:**

Forrest Oliveria R8 FHP	Eric Twombly R6 MS	Ron Perisho Ouachita NF, R8
Nick Crookston Int. Res. Sta.	Rich Teck Timber Serv. Ctr.	Alan Ager Umatilla NF
Rhey Solomon WO EM	Joy Berg WO EM	David Cleaves WO EM
Pat Jackson R3	Susan Grey R2	Sue Prece R4

**Accomplishments:**

SUPPOSE integration with supporting utility completed 8/97; testing now underway. Rulebase Toolkit was delivered to FHTET and is being evaluated. FHTET technical writer is currently writing the User's Guide for the Rulebase Toolkit with funding from R8; target completion date is 11/97. Three models (an economic model, a sedimentation model, and a wildlife model) were ported to 615 and integrated within INFORMS for use on the Ouachita NF (funded by the Ouachita NF). Alan Ager is finalizing the port of UPSET over to 615, so UPSET can then be integrated into INFORMS. FHTET provided advice and documentation to the TSPAS (an economic model) development team to facilitate possible integration of that tool within INFORMS. FHTET staff produced a rapid prototype of the Decision Protocol as an integrated component of INFORMS (funded by WO EM). FHTET staff authored or co-authored 2 papers (1 on the Decision Protocol and 1 on the Rulebase Toolkit) for presentation at RT in Beijing, China.

**Final Products and Delivery Dates:**

SUPPOSE integrated within INFORMS (testing underway)	August 1997
Decision Protocol prototype completed	July 1997
Ouachita NF models ported	April 1997
Rulebase Toolkit delivered to FHTET	August 1997

**Project:** II.7.c Documentation of Landscape Assessment Methods

**Project Leader:** Williams

**Objectives:** To complete and document the procedures used in Region 1 for insect and pathogen-related landscape assessment.

**Cooperators:**

Jim Byler	Sue Hagle
R1 FHP	R1 FHP

**Accomplishments:**

This task was refocused somewhat when the follow-up TDP was not approved. Beyond ongoing support to R1 FHP staff related to data management issues, a substantial amount of statistical support was provided in order to summarize project data for various locations within the region. Midway through FY97, procedures/methods developed through this project were deemed stable and a meeting was held in late July to determine the final set of tasks that would bring this project to closure. Tasks included final refinement of data structures relevant to R1 and a review of components of the extensive project report that is being written. Work will continue into early FY98 in order to produce 2 project documents; a detailed report and a more glossy publication suitable for public consumption. A few weeks of effort will occur in FY98 to complete automated summary routines that feed on the refined data structure.

**Final Products and Delivery Dates:**

Intermediate products shown above. Closeout of project expected in mid FY98.



**Project: II.8.a FHTET Internet and Intranet Services**

**Project Leader:** Roschke

**Objectives:** Sustain internet accessibility to FHTET information and products. Support Forest Health Protection communications goals through web pages and a server site for FHP units.

**Cooperators:**

Andy Wilson  
Information Specialist  
Public Affairs Office, WO

Leah Clark  
FHP Communications Manager  
Forest Health Protection, WO

**Accomplishments:**

The Web Team maintained information at the FHTET web site, and enhanced capabilities by completing the following:

- o HTML and PDF versions of each FHTET Update
- o Added web-ready Update graphics to HTML version
- o Web versions of FHTET capability documents
- o Web versions of quarterly FHTET publications list from the Update
- o Initiated including on-line abstracts for all FHTET publications commencing August 1997
- o Developed efficient process for concurrent development of paper and web-based publications
- o Automated generation of Web site access reports

The team started discussions and analysis of FHTET objectives to establish intranet services and capabilities as a means of facilitating work with external customers and communication among FHP committees and their members; ftp infrastructure for internal FS distribution of FHTET products; web-technology based forms to allow remote queries of ORACLE databases such as PURS; and groupware implementation to facilitate collaboration within spatially distributed teams.

**Final Products and Delivery Dates:**

- |  |                     |
|--|---------------------|
| 1. Redesigned FHTET web page for greater ease of use.                                      | August 1997         |
| 2. Maintained 3 web pages; FHTET, Forest Health, and Forest Service sites in Fort Collins. | Throughout the year |
| 3. Provided web server site for use by Forest Health Protection specialists.               | March 1997          |

Project Area III. Treatment Technology

**Project:** III.1.a SpraySafe Manager-FSCBG Aerial Application Decision Support System

**Project Leader:** Barry/Eav

**Objective:** To provide land managers with extended FSCBG aerial spray model capability with an easy-to-use decision support system (DSS) to support safe, efficacious, and economical application of pesticides.

**Cooperators:**

Brian Richardson  
New Zealand  
Forest Research Institute

Harold Thistle  
MTDC

Milt Teske  
CDI

**Accomplishments:**

In April of 1997 Milt Teske, contractor with Continuum Dynamics, Inc. spent three and a half weeks in New Zealand working with Brian Richardson of the Forest Research Institute (FRI) to complete Version 1.0 of SpraySafe Manager. A paper has been written on this subject by Milt Teske and submitted to Bov Eav. The beta version of the user guide has been completed by FRI.

**Final Products and Delivery Dates:**

1997 FSCBG Implementation into SpraySafe Manager - An Update Toward Version 1.0.



**Project:** III.1.b Field Meteorology Handbook for Resource Managers

**Project Leader:** Barry/Thistle

**Objective:** To prepare and publish a book on complex terrain and forest meteorology for us in planning and conducting weather-sensitive forestry operations.

**Cooperators:**

Harold Thistle  
MTDC

Dave Whiteman  
Battelle NW / Dept.  
of Energy

Bruce Grim  
U.S. Army

Rusty Billingsly  
Nat'l Weather Service

Carl Gorki  
Nat'l Weather Service

Andy Edman  
Nat'l Weather Service

Allen Farnsworth  
Region 3

Peter Lahm  
Region 3

**Accomplishments:**

The first draft of the book has been completed, including figures. The full book review cycle is commencing.

**Future Products and Delivery Dates:**

Textbook

(Complex Terrain Meteorology for National Resource Managers). January 1999

**Project:** III.2.a Dispersion and Fate of *Bacillus thuringiensis* (Bt) in Forested Canyons

**Project Leader:** Barry

**Objectives:** To complete final work to evaluate the dispersion and fate of *Bacillus thuringiensis* (Bt) in forested mountain terrain; to evaluate the FSCBG model in predicting Bt drift; and to measure Bt drift and canopy deposition.

**Cooperators:**

John Anhold  
Region 4

Bob Smith  
Abbot Laboratories

**Accomplishments:**

A journal manuscript was to be completed by January 1997. This has not yet been done.

**Future Products and Delivery Dates:**

Data unavailable at this time.

**Project:** III.2.b Environmental Fate of Bacillus thuringiensis var. kurstaki (Btk) in a forest ecosystem in the Wasatch Mountains, Utah.

**Project Leader:** Reardon (initiated by Barry)

**Objectives:** The focus of this project was extensively revised in FY97 due, in part, to the inability to distinguish among Btks found in commercial formulations and wild populations in the soil (i.e. several formulations of Btk were aurally applied during the gypsy moth eradication program).

**Cooperators:**

Bruce Grim  
US Dept. of Defense, Army

Bob Smith  
Abbott Laboratories

Jack Adams  
Bioremediation Lab.  
Weber State Univ.

John Anhold  
R4-FHP

Normand Dubois  
Northeastern Forest Experiment Station

**Accomplishments:**

The emphasis in FY97 was to use fatty acid composition in the vegetative cells as a potential marker to distinguish among Btks. Four formulations of Btk (Foray 48B, Foray 48F, Dipel 6AB, Thuricide 48LV) as well as a stock culture of Bti (as positive control) were obtained for analysis. The analysis will begin in November 1997.

The soil samples collected each year including 1997 are stored in the freezer and will not be processed until a reliable method is available to distinguish among Btks.

**Final Product and Delivery Date:**

Commercially available technique to identify Btks, and persistence data for Btk spores in soil. September 1998

**Project:** III.3.a Meteorological Instrumentation Support in FHP Operations

**Project Leader:** Thistle

**Objective:** To support FHP operations with meteorological data gathering.

**Cooperators:**

Andy Kulla  
Region 1

Iral Ragenovich  
Region 6

Ed Holsten  
Region 10

Patrick Shea  
PSW

Warren Webb  
Oregon State Univ.

**Accomplishments:**

Two areas of support were carried out this year. The first involved the ongoing analysis of meteorological data collected during 8/96 at the Wind River Canopy Crane site. This data collection was in support of research conducted by OSU in conjunction with R6, R10 and PSW.

The second support area was the deployment of two meteorological stations in support of an herbicide spraying to restore Elk winter range in the Bitterroot Mountains. MTDC supported this effort with equipment and personnel and also produced a report (Thistle H. and M. Huey 'Meteorological Data Collection at Mormon Ridge, MT' 9734-2822-MTDC, Missoula MT, May 1997) based on a previously collected data set describing meteorological conditions in the area.

**Final Product and Delivery Date:**

Determined as tasks arise.



**Project:** III.3.b Spray Drift Mitigation

**Project Leader:** Thistle

**Objective:** To minimize off-target drift of pesticide by investigating the causes of drift and proposed solutions. Specific areas of focus are drift in complex terrain, the effect of vegetation and vegetative barriers on drift and the role of atmospheric stability on drift.

**Cooperators:**

Bill May  
Lincoln Ventures

George Ramsey  
DuPont Corporation

Dave Whiteman  
Pacific Northwest  
National Lab.

**Accomplishments:**

Various efforts are ongoing in this area. DuPont has sent MTDC \$5K to develop a training video on the relationship between meteorological conditions and off target drift of pesticides. Harold Thistle travelled to Newark, DE in June to initiate this effort. We have supplied them with animation templates and plan to film a segment of this video in Montana. Harold Thistle attended the Spray Drift Coalition meeting in Washington, D.C. in March. This group is developing regulations for pesticide application and is looking for technical guidance.

One area of work in this project is the development of the ValDrift complex terrain dispersion model which simulates pesticide dispersion in mountain valleys. A talk was given at the American Society of Agricultural Engineers annual meeting using ValDrift as an applied problem solver. MTDC has sent \$4K of funding to Allwine Environmental and \$3K to Battelle Pacific Northwest Laboratories to utilize the VALDRIFT model in applied pesticide drift scenarios. A journal article and a proceedings paper were published in this project this year.

A project was inherited from the Davis Office to investigate the standard guidance being given to applicators regarding positioning of nozzles on spray booms below aircraft. Simulations run using the FSCBG model indicate that the standard guidance may increase spray drift in some cases. This is an important result and a paper has been published.

A report was published on the optimization of pesticide application (Ammons et al., 1996).

Whiteman C.D., K.J. Allwine, H.W. Thistle, X. Bian and J.W. Barry 'A Screening Exercise to Estimate the Maximum Distance of Significant Drift of Herbicide in Complex Terrain' ASAE Paper# 971073, St. Joseph MI, August 1997

Allwine K.J., X. Bian, C.D. Whiteman and H.W. Thistle 'VALDRIFT-A Valley Atmospheric Dispersion Model' Journal of Applied Meteorology, Vol. 36, No. 8, August 1997

Ammons R., H. Thistle and J. Barry 'Optimized Pesticide Application' 9634-2831-MTDC , Missoula, MT December 1996

Teske M.E., J.W. Barry and H.W. Thistle 'Nozzle Placement for Drift Minimization', ASAE Paper# 971071, St. Joseph MI, August 1997

**Final Products and Delivery Dates:**

Publish journal article on ValDrift.

FY97

Co-produce video with DuPont.

FY98

**Project:** III.3.c Pheromone Application Support

**Project Leader:** Trent

**Objective:** The overall objective is to help make available equipment and procedures for applying pheromone both aerially and on the ground. The focus of this project is the aerial dispersal of pheromone beads or flakes applied in a tacky liquid (sticker).

**Cooperators:**

Win McClane  
APHIS

Donna Leonard  
R8-FHP

**Accomplishments:**

Activity in this project has been directed toward improving aerial application dispensing equipment for tacky pheromone carriers. Andy Trent traveled to Mission, TX to see APHIS equipment used to do this type of application. Andy Trent also travelled to Virginia to see equipment in action and meet with the principal FS operational users. Recommendations have been made regarding the system components (tubing, valves, etc.) used operationally. A plan has been developed to build a prototype system incorporating design suggestions in the MTDC shop and to install and fly this equipment in Texas in the early Spring of 1998. This project is being closely coordinated with Dick Reardon (FHTET-Morgantown).

**Final Product and Delivery Date:**

Prototype system and project report.

FY98

**Project:** III.3.d DGPS Aircraft Guidance in Aerial Spraying

**Project Leader:** Thistle

**Objective:** The objective of this project is to evaluate and understand DGPS equipment used in FS and cooperator pesticide application. In aerial spraying it is important to apply pesticide as accurately as possible in order to improve its efficiency and thereby reduce costs and the impact on the environment. It is also important to know aircraft location in real-time and to have a permanent record of its flight patterns. Therefore, some type of guidance/tracking system is a must. A guidance system is needed to assist the pilot in the precise application of the material, and a tracking system is needed to provide a record of where the aircraft flew for later analysis of the operation, or input into GIS for future information and legal documentation. In the post analysis of the operation, skips can be determined and respray accomplished.

**Cooperators:**

John Ghent  
Region 8

John Omer  
Region 9

Arnold Baird  
AgNav

30 State personnel attended demonstration

**Accomplishments:**

The focus of this project this year is a test and demonstration performed in Harrisonburg, VA to evaluate the interface between onboard aircraft guidance systems and FS GIS. The test was planned and a published test plan was distributed to system manufacturers. The tests occurred and were attended by approximately 30 people from FS, state cooperators, the private sector and other Federal agencies. A final report on this work is being edited and will be published. This project will be terminated this year. It is anticipated that MTDC will offer ongoing support in this area. This support has been incorporated under Engineering Services in the FY98 Program of Work.

Harold Thistle participated in aerial applicator training for the Oklahoma Association of Aerial Applicators in Oklahoma City in January. All direct costs were reimbursed by OAAA. This type of activity is both entrepreneurial and builds goodwill and technical competence in the applicator community at large.

Thistle H., 'Harrisonburg Spray Aircraft Navigation Demonstration Test Plan'  
9634-2858-MTDC, Missoula MT, December 1996

**Final Product and Delivery Date:**

Trial test plan.

FY97

Trial final report.

FY98



**Project:** III.3.e Seed Orchard Sanitation

**Project Leader:** Windell/MTDC

**Objective:** The objective of this project is to investigate equipment for use in the removal of cones and other organic matter that provides pest habitat in seed orchards.

**Cooperators:**

Bill Randall  
Region 6

Bill Sery  
Region 9

**Accomplishments:**

Activity in this project has focused on two machines. A small vacuuming unit was purchased and tested at the Oconto River Seed Orchard last fall. Orchard ground surface conditions have not been correct to extensively test this machine yet. An effort is under way to evaluate a rake type machine that uses rubber fingers to collect debris. These machines were developed for golf courses and may be very useful in this application.

MTDC is developing support for the evaluation of a vacuuming machine that is commercially available. A report (Windell K.N., H.W. Thistle, S. Katovich, W. Sery and J.W. Barry 'Non-Chemical Seed Tree Orchard Sanitation' ASAE Paper#971053, St. Joseph MI August, 1997) was presented as a poster session at the American Society of Agricultural Engineers annual meeting. The corresponding paper serves as the final report for this project. The project will continue next year as a jointly funded project with state and industry cooperation and is not in the FY98 FHP/MTDC program of work. This effort is still noted as a high priority need by the Seed and Cone Insect Working Group.

**Final Product and Delivery Date:**

Final Project Report and equipment to orchards.

FY97

**Project:** III.3.f Engineering Services

**Project Leader:** Thistle

**Objective:** The objective is to provide prompt engineering services on request, and to coordinate program planning support to the sponsoring Washington Office unit. At the request of Forest Health Protection (FHP), the Center conducts special investigations and studies; participates in field programs; evaluates employee suggestions; contacts field personnel to determine instrumentation and equipment needs; delivers presentations on FHP methods at training sessions, meetings, and workshops; provides follow-up services on completed development projects and answers requests for information from field units, Government Agencies, and industry; publishes reports; prepares manuscripts for journal publications; and handles program planning and Washington Office coordinator activities for Forest Insect and Disease Management projects at the Center.

**Cooperators:**

Arnett Jones EPA	Tim McConnell Region 1	Bill Sery Region 8
Larry Barber Region 8	Bruce Grim U.S. Army	Dave Esterly DuPont
Dave Valcore Dow Elanco	Bruce Upchurch Union Camp	Robert Fox Agricultural Research Service
Norm Akesson University of California at Davis		

**Accomplishments:**

The primary activities in Engineering Services this fiscal year have been report writing and administrative. A final report has been written on the stationary tree sprayers (Kilroy et al., 1996), and an interim report has been written on electronic sketchmapping. An engineering design to use the stationary tree sprayer system on multiple trees has been developed by Tony Jasumback and was sent to Larry Barber in Asheville, NC. A spatial analysis of the Mormon Ridge aerial spraying to restore Elk winter range was performed. This involved MTDC deploying collecting, analyzing and preparing a map of deposition. On the administrative side, we have prepared a preliminary cost/benefit analysis of the program, cooperated on development of the FHTET marketing brochure, FHTET 5 year accomplishment report, the FHTET capability statement package and action items from the FHTET Team Meeting. The FY96 MTDC/FHP Accomplishment Report was also published by MTDC this year. The transition of sponsors has caused substantial activity in the administrative area that has included three meetings attended by Harold Thistle in Ft. Collins (Dec., June and July) and in Davis, CA (Jan.). Harold Thistle attended the FHTET Steering Committee Meeting to present the MTDC program in Pittsburgh

(June). Harold Thistle travelled to Morgantown, WV to present the preliminary FY98 Program of Work in May. Harold Thistle chaired the Spray Modeling and Application Technology Working Group in Minneapolis in August. This working group meeting is held in conjunction with the Annual Meeting of the American

Society of Agricultural Engineers and MTDC authored or co-authored 4 papers at this meeting. Harold Thistle also traveled to Brian Head, Utah to attend the Bark Beetle Working Group Meeting in September. MTDC has also been working actively to encourage ideas for the FHP/MTDC program from FHP field personnel.

Thistle H., P. Greenfield, T. McConnell, R. Myhre and L. Rankin 'Sketchmapping Interim Report' FHTET 96-31 Davis, CA December, 1996

Kilroy W., D. Rising and H. Thistle 'Single-Tree Spray Application Project: Final Report' 9634-2838-MTDC, Missoula, MT October 1996

Thistle H.W., MTDC/FHP 'Technology Development Program, FY96 Accomplishment Report' FHTET 96-32 Davis, CA 1996a

**Final Product and Delivery Date:**

As determined by tasks.

**Project:** III.3.g Decision Support System Model Testing and Evaluation

**Project Leader:** Thistle

**Objective:** Decision support systems (DSS) have been developed that use descriptions of meteorological processes and descriptions of the application methods and equipment to simulate dispersion and deposition of airborne materials. Analysis of data is ongoing and models have been improved and verified based on field trials.

**Cooperators:**

Bruce Grim  
USDOD

Terry Biery  
U.S. Air Force

Dave Valcore  
Spray Drift Task Force

Robert Mickle  
Canada

Brian Richardson  
New Zealand

Iral Ragenovich  
Region 6

Ed Holsten  
Region 10

**Accomplishments:**

The work on this project this year has focused in two primary areas. The first is to establish a program of work to develop a model to predict in-canopy dispersion of pheromone. The second is to develop a real-time drift indicator based on simple modeling approaches. Harold Thistle traveled to Wind River, WA in October to discuss work performed last August in support of pheromone dispersion model development. Direct costs were paid by the University of Washington. Harold Thistle traveled to Corvallis, OR in October and again in April. MTDC has provided \$7K of funding to Dr. Warren Webb of OSU to reduce and analyze in-canopy plume spread data. Pheromone dispersion modeling will be proposed next year as a project in the program of work.

The second area is the development of real time modeling techniques. Discussions have been held with various DGPS Aircraft Guidance system manufacturers along these lines. In support of this work a demonstration of wing mounted meteorological sensors was held in October in Missoula, MT. Accurate real time meteorology is critical to the success of this concept. Harold Thistle also met with representatives of the Army and Air Force in Reno, NV in December to discuss ongoing Air Force work along these lines. A statement of progress was written in April/May listing the prior work done by MTDC and speculating on future directions.

A MTDC Tech Tip and a book chapter were written out of this project this year.

Teske M.E., H.W. Thistle and J.W. Barry 'Topics in Aerial Spray Drift Modeling', Environmental Modeling-Vol. 3. Ed. P.Zannetti. Computational Mechanics Publications, Boston 1996

Thistle H. and W. Kilroy 'Demonstration of the Aventure Aircraft-Mounted Meteorological Measurement System' 9734-2323-MTDC, Missoula MT, May 1997



**Final Product and Delivery Date:**

Version 5.0 of FSCBG (Windows environment).

FY99

Models (FSCBG, ValDrift, AgDrift) available on the world wide web.

FY99

**Project:** III.3.h Decision Support System Enhancement and OS Updates

**Project Leader:** Thistle

**Objective:** To incorporate new technology into the DSS so that the FS systems remain state-of-the-art and user friendly.

**Cooperators:**

John Ghent  
Region 8

Dan Twardus  
Northeastern Area

GYPSES and FSCBG User Groups

**Accomplishments:**

This project has been inherited this year from the FHTET-Davis Office. The main thrusts of this project are the development of a new version of FSCBG (Version 5) and the movement of the FSCBG model into a Windows sub-system with Windows menus. These two objectives will be met with the development of Version 5.0 that will be available for release next calendar year. The programming work will be done at FHTET-Ft. Collins in close cooperation with Continuum Dynamics, Inc. of Princeton, NJ in an oversight role. Harold Thistle travelled to Ft. Collins to meet with Milt Teske of CDI, Bov Eav, Missy Shelley and Pat Skyler. A development schedule was proposed and initiated. MTDC will maintain the role of advisor as to technical direction on this work.

Teske M.E., J.W. Barry and H.W. Thistle 'Aerial Spray Model Application Parameter Optimization' ASAE Paper# 971074, St. Joseph MI, August 1997

**Final Product and Delivery Date:**

Windows version of FSCBG.

FY98

**Project:** III.3.1 FSCBG System and User Group Management

**Project Leader:** Thistle

**Objective:** To support training and the technical transfer of models that support the safe and effective application of pesticides.

**Cooperators:**

Model users are: Forest Service, state, industry, and international entities.

**Accomplishments:**

A meeting to discuss on-going task orders and interfacing of the model into a Windows version (v5.0) was held in June 1997. Plans are to have a beta of version 5.0 ready for testing in the spring or summer of 1998.

The Seventh Annual National Spray Model and Application Technology Steering Committee Meeting was held in Minneapolis, MN in August 1997. A report has been prepared on this meeting.

FSCBG model runs were conducted in March 1997 and in September 1997 by the FHTET-Morgantown office in support of the proposed helicopter application of herbicides on the Flathead National Forest, Region 1 and the Stanislaus National Forest, Region 5.

**Final Product and Delivery Date:**

This project was inherited from the FHTET-Davis Office and canceled at midyear.

**Project:** III.4.a QA/QC Standards for Formulations of Semiochemicals

**Project Leader:** Reardon

**Objectives:** To develop and implement quality assurance/quality control (QA/QC) standards for formulations of semiochemicals that are used for monitoring and managing Lepidoptera.

**Cooperators:**

Barbara Leonhardt  
USDA ARS

Donna Leonard  
R8-FHP

Vic Mastro  
USDA APHIS

Brad Onken  
NA-FHP

**Accomplishments:**

A list of potential cooperators and products has been drafted. Preliminary set of QA/QC guidelines developed.

**Final Product and Delivery Date:**

Prototype set of QA/QC guidelines for semiochemicals. December 1998



**Project:** III.4.b 4-AA to Protect Individual Trees from Southern Pine Beetle.

**Project Leader:** Reardon

**Objectives:** To refine application technology for 4-AA in an effort to develop an operational technique to protect high-value trees from infestation by southern pine beetle (SPB).

**Cooperators:**

Jane Hayes  
Southern Research Station

Roberta Fitzgibbon  
R8-FHP

Stephen Clark  
R8-FHP

**Accomplishments:**

Discussions with 3-M Canada are continuing concerning the production of microcapsules containing 4-AA. Field plots were located and 3 slow release devices of 4-AA along with several placement patterns were evaluated against SPB. Unfortunately, SPB populations did not develop as anticipated and only preliminary data was obtained.

**Final Product and Delivery Date:**

Slow release device for 4-AA that is efficacious and environmentally acceptable. October 1998

**Project:** III.4.c Develop Semiochemicals for Operational Use

**Project Leader:** Reardon

**Objectives:** 1) To provide two efficacious commercial formulations (Hercon flake and Thermo Ecotek Inc. bead) containing racemic disparlure for managing low density building gypsy moth populations on large acreages. 2) To identify the most cost-effective, efficacious dose, application rate and tank mixes for the two products.

**Cooperators:**

Andy Trent MTDC	Harold Thistle MTDC	Vic Mastro USDA-APHIS
Barbara Leonhardt USDA-ARS	Kevin Thorpe USDA-ARS	Donna Leonard R8-FHP
Priscilla MacLean Hercon, Inc.	Ivan Rash Loveland Industries	Brad Onken R8-FHP
Chris Dively Thermo Ecotek, Inc.		

**Accomplishments:**

FHTET solicited via an informal request a cost estimate from private industry (i.e. Harold's Flying Service, Schiffer Flying Service and K&K Aircraft) to develop pheromone application technology for the two slow release formulations of racemic disparlure. High estimated costs and potential exclusive use of the technology caused efforts to be directed toward USDA APHIS Aircraft Operations and MTDC. A commercially available and inexpensive boom nozzle used for agricultural crops was evaluated using ground application equipment. The flakes and beads were applied through the nozzle without problem. A commercially produced sticker/extender (Loveland Industries) was evaluated and provided excellent suspendability of the formulations.

A replicated field trial was conducted using aerial application of flakes both with and without sticker. Preliminary results indicate the sticker is essential (i.e vertical distribution of flakes) for acceptable efficacy.

**Final Product and Delivery Date:**

Operationally usable system to aerially apply slow release formulations of racemic disparlure. December 1998

**Project:** III.4.d Analysis and Environmental Fate of Insect Growth Regulators

**Project Leader:** Reardon

**Objectives:** 1) To develop a method of extraction and HPLC/electrospray/mass spectrometric analysis of tebufenozide (RH-5992, the active component of MIMIC) from environmental samples; and 2) to study the persistence of MIMIC on tree foliage, in underlying ground litter, and in soil in an Ohio forest and a West Virginia forest throughout a growing season and post leaf-fall.

**Cooperators:**

John Long  
Rohm and Haas Co.

Mary Wimmer  
Dept. of Biochemistry,  
West Virginia University

Brad Onken  
NA-FHP

**Accomplishments:**

All field collected leaf, litter, and soil samples (collected from 1994 through 1996) have been processed and are ready for analysis. The mass spectrometric analysis of tebufenozide from environmental samples did not provide consistently reliable results; therefore, the environmental samples are being analyzed using HPLC.

**Final Product and Delivery Date:**

Residue profile data for tebufenozide collected from environmental samples in broadleaved forests to support the registration of tebufenozide. December 1997

**Project:** III.4.e Optimize Nucleopolyhedrosis Products for Operational Use

**Project Leader:** Reardon

**Objectives:** To improve application technology, formulations and strains of nucleopolyhedrosis viruses (NPVs; e.g., Gypchek, TM-Biocontrol-1, and Neocheck-S) registered by the USDA Forest Service.

**Cooperators:**

John Podgwaite  
Northeastern Forest  
Experiment Station

John Cunningham  
Forestry Canada

Kevin Thorpe  
USDA-ARS

Jeff Witcosky  
R8-FHP

Bernie Raimo  
NA-FHP

Linda Butler  
West Virginia Univ.

**Accomplishments:**

- o Conducted evaluation of standard formulation of Gypchek (i.e. Hamden strain) and modified strain of Gypchek (provided by Jim Slavicek, USDA Forest Service, NEFES) using ground application equipment.
- o Applied Gypchek as part of long-term nontarget project in Virginia and West Virginia.
- o Initiated efforts with Abbott Laboratories to obtain the "rights" to modify and to manufacture Carrier 038.
- o Aerially applied Gypchek as part of spray deposition along forest edge evaluations using lidar and foliage collectors.

**Final Product and Delivery Date:**

Efficacious dose, formulations, and application technology for nucleopolyhedrosis virus products. December 1998



**Project:** III.4.f Silvicultural Prescriptions for Gypsy Moth - Demonstration

**Project Leader:** Reardon

**Objectives:** To determine the relative efficacy of selected silvicultural and insecticide options for minimizing gypsy moth impacts to forest stands.

**Cooperators:**

Russ MacFarlane  
Jefferson NF

Kurt Gottschalk  
Northeastern Forest  
Experiment Station

Jeff Witcosky  
R8-FHP

Brad Onken  
NA-FHP

**Accomplishments:**

Forest inventory and gypsy moth density data were collected from a series of 35 stands that received silvicultural options. Data was also collected from additional stands as untreated controls located on the Jefferson National Forest. The stands have been monitored since 1991 but gypsy moth populations have not developed as anticipated; therefore, the evaluation is "on-hold". The Northeastern Forest Experiment Station will continue to provide minimal funding to collect baseline data from these stands.

**Final Product and Delivery Date:**

Recommendations concerning the implementation of silvicultural options for managing gypsy moth in the southern Appalachians. September 1997

**Project:** III.4.g Development of Entomophaga maimaiga as a biopesticide for Operational Use

**Project Leader:** Reardon

**Objectives:** 1) To determine effective methods for laboratory rearing and for dispensing the fungus (the only method now available involves movement of fungal spores in soil); 2) to continue to collect nontarget impact data; 3) to develop an effective formulation for ground/aerial application of the fungus; 4) to obtain the necessary experimental use permits for the fungus from US-EPA; and 5) to use the fungus as a component of suppression, slow-the-spread, and eradication programs.

**Cooperators:**

Ann Hajek  
Cornell University  
Dept. of Entomology

Ralph Webb  
USDA ARS

Jeff Witcosky  
R8-FHP

Dennis Souto  
NA-FHP

**Accomplishments:**

- o The development of an economical laboratory rearing technique for Entomophaga maimaiga has been difficult although several approaches still look promising and need continued evaluation.
- o Nontarget lepidopteran larvae were collected from plots within the Butler (long-term nontarget project) plots in VA and WV.
- o Preliminary contacts made with US-EPA concerning required nontarget testing for registration of the gypsy moth fungus.

**Final Product and Delivery Date:**

An efficacious pathogen for use as a biopesticide in suppression, slow-the-spread, and eradication programs. December 1999.

**Project:** III.5.a Establish an Effective Natural Enemy Complex in North America for Hemlock Woolly Adelgid

**Project Leader:** Reardon

**Objectives:** 1) To survey for potential exotic and native predators and pathogens of hemlock woolly adelgid (HWA); 2) to develop methods for rearing predators of HWA for eventual release; 3) to design standard protocols to sample HWA and predator populations; 4) to release, to determine the effectiveness of, and to establish natural enemies of HWA; and 5) to develop an effective biological control program for HWA.

**Cooperators:**

Mark McClure Connecticut Agricultural Experiment Station	Dennis Souto NA-FHP	Brad Onken NA-FHP
Kathy Shields Northeastern Forest Experiment Station	Michael Montgomery Northeastern Forest Experiment Station	Rusty Rhea R8-FHP
Chuck Parker USDI USGS, Biological Research Division	Scott Salom Virginia Polytechnic Institute & State Univ.	Bruce Parker University of Vermont

**Accomplishments:**

- o Since 1995, a total of 18,500 Pseudoscmynus tsugae have been released in Connecticut and for the first year in Virginia
- o Laboratory colonies of P. tsugae are being maintained by the New Jersey Dept. of Agriculture and Connecticut Agricultural Research Experiment Station.
- o A survey for pathogens of hemlock woolly adelgid is underway with collections of HWA from 4 states.
- o Several species of predators of hemlock woolly adelgid were collected in People's Republic of China and currently in culture at the USDA Forest Service quarantine facility in Ansonia, Connecticut.
- o Preliminary survey for areas with at least two of the following pests balsam woolly adelgid, hemlock woolly adelgid and beech scale for collection of natural enemies.

**Final Product and Delivery Date:**

Establish exotic/manipulate native natural enemies of HWA in the eastern United States. December 1998.

**Project:** III.5.b Develop Biocontrols for Mile-A-Minute Weed

**Project Leader:** Reardon

**Objectives:** To coordinate the establishment of an effective natural enemy complex for Mile-a-Minute Weed

**Cooperators:**

Gary DeBarr  
Southern Research  
Station

Bill Day  
USDA-ARS

Gary Buckingham  
USDA-ARS

Gary Johnston  
USDI-NPS

Tom Hall  
PA Bureau of Forestry

Scott Kurtzman  
Gladfelter Paper Co.

Ernest Delfosse  
USDA-ARS

Tom Finn  
Virginia Dept. of  
Agriculture and  
Consumer Services

Phil Tipping  
Maryland Dept. of  
Agriculture

Jim Frederick  
Univ. of Delaware,  
Dept. of Entmology &  
Applied Ecology

Yun Wu  
Michigan Technological  
University

Jim Meeker  
Florida Div. of Forestry

James Brown  
R8-FHP

Will Mountain  
PA Dept. of Agriculture

Amy Onken  
NA-FHP

**Accomplishments:**

- o Plots established in Maryland, Pennsylvania, Delaware, and Virginia
- o Natural enemies collected, and associated damage recorded for plots in each state.
- o Survey for arthropods and pathogens of mile-a-minute continue in People's Republic of China. Laboratory colonies of several natural enemies initiated for host preference testing.
- o Biology, rate of spread and life history data collected for mile-a-minute in plots in each state.

**Final Product and Delivery Date:**

Effective natural enemy complex for mile-a-minute weed. December 1999



**Project:** III.5.c Impact of Exotic Natural Enemies Released in North America on Nontarget Lepidopteran Hosts

**Project Leader:** Reardon

**Objectives:** 1) To determine if the gypsy moth tachinid parasite Compsilura concinnata is an important source of mortality on two species of native forest Lepidoptera: the solitary feeder spicebush swallowtail (Papilio troilus) and the gregarious feeder Prometheus moth (Callosamia promethea); 2) to determine if naturally occurring population densities of gypsy moth influence attack rates by C. concinnata on P. troilus and C. promethea; and 3) to determine the impact of C. concinnata and other gypsy moth parasites on naturally occurring populations of brown-tail moth, Euproctis chrysorrhoea (L.).

**Cooperators:**

Joe Elkinton

Univ. of Massachusetts

Roy VanDriesche

Univ. of Massachusetts

Dennis Souto

NA-FHP

**Accomplishments:**

- o Literature and preliminary field data indicates that the tachinid Compsilura concinnata has a greater than anticipated negative impact on populations of native large moths.
- o The study is broadening in scope with an additional evaluations of the recently released polyphagous gypsy moth ichneumonid parasite Coccygomimus disparis.

**Final Product and Delivery Date:**

Data concerning the impact of exotic polyphagous parasites on host and nontarget species. December 1999.

**Project:** III.5.d Biological Control Program for Woodwasp, Sirex noctilio, in South America

**Project Leader:** Reardon

**Objectives:** 1) Assist in the development of a biological control program for the woodwasp Sirex noctilio, including the establishment of a parasite and nematode complex for minimizing damage caused by this pest species; and 2) provide training to forest managers representing several South American and African countries in biological control and monitoring techniques for S. noctilio.

**Cooperators:**

Sean Murphy	Edson Tadeu Iede	Andy Knapp
Intern'l Inst. of BioControl	CNP Florestas/EMBRAPA Brazil	R4-FHP

Dennis Haugen  
NA-FHP

**Accomplishments:**

- o Kamona strain of nematode being reared in the laboratory and limited field releases.
- o The parasite Megarhyssa nortoni being reared in the laboratory.
- o Preliminary evaluation of aerial survey methods to locate Sirex noctilio damage and host type.
- o Biological control workshop held in November 1996 with participants from several South American countries and South Africa.
- o New 3-year participating agreement signed.

**Final Product and Delivery Date:**

IPM program for Sirex noctilio in Brazil. December 2001.

**Project:** III.5.e IPM Program for Common Pine Shoot Beetle

**Project Leader:** Reardon

**Objectives:** To assist in the development of an operational integrated pest management (IPM) program for the common pine shoot beetle.

**Cooperators:**

Vic Mastro  
USDA-APHIS

Bill Kauffman  
USDA-APHIS

Robert Hack  
North Central Forest  
Experiment Station

Clifford Sadof  
Purdue Univ.

Debbie McCullough  
Michigan State Univ.

Janet Knodel  
Cornell Univ.

David Nielson  
Ohio State Univ.

Mike Connors  
NA-FHP

**Accomplishments:**

- o Pilot projects completed in cooperation with several Christmas tree growers in Michigan and Indiana.
- o Compliance agreement drafted for movement of Christmas trees. USDA-APHIS, private industry and State Departments of Agriculture/Forestry reviewing agreement.
- o Preliminary evaluations completed concerning the interaction of native and exotic clerid predators.
- o USDA-APHIS has terminated efforts to establish an exotic clerid predator for common pine shoot beetle at the request of several State Departments of Agriculture.

**Final Product and Delivery Date:**

Operational compliance agreement program for movement of Christmas trees. Data to support release of exotic predator. October 1997

**Project:** III.5.f Biological Control of Weeds in the Western U.S.

**Project Leader:** Reardon

**Objectives:** To compile and distribute information on the past and current use of biological controls to manage noxious weeds in forest ecosystems in the West.

**Cooperators:**

George Markin  
Intermountain Forest and  
Range Experiment Station

Dave Thomas  
WO-FHP

James Olivarez  
R1-FRM

Jed Dewey  
R1-FHP

**Accomplishments:**

- o The primary objective of developing a database of releases of biological control agents in forest ecosystems in the West was placed "on-hold" based on discussions with Rita Beard and Jim Olivarez.
- o A technology transfer video entitled "How to guide for collecting, transporting, distributing and monitoring biological control agents for invasive exotic weeds" is being produced in cooperation with R-1 Forest and Rangeland Management.

**Final Product and Delivery Date:**

Technology transfer tool to assist in providing a uniform approach for using biological control agents. December 1998.



**Project:** III.5.g Cooperative Biological Control Projects

**Project Leader:** Reardon

**Objectives:** To expedite among several USDA agencies (Agricultural Research Service, Forest Service, and Animal and Plant Health Inspection Service) the development and use of natural enemies to manage forest and urban pest populations.

**Cooperators:**

Roger Fuester  
USDA-APHIS

Paul Schaefer  
USDA-APHIS

Bill Kauffman  
USDA-APHIS

Jim Unger  
Pennsylvania Bureau  
of Forestry

Mike Blumenthal  
Pennsylvania Bureau  
of Forestry

**Accomplishments:**

- o Aleiodes (=Rogas) indiscretus, a braconid gypsy moth parasites, colony maintained at the ARS quarantine facility in Newark, Delaware.
- o Aleiodes indiscretus released at two sites in Pennsylvania (both sites had low-density gypsy moth and nontarget lepidopteran populations).
- o Aleiodes collections continued in India with shipments to ARS.

**Final Product and Delivery Date:**

Aleiodes indiscretus established in the East. December 1998.

**Project:** III.5.h Mycorrhizae to Suppress Root Diseases on Conifers in Nurseries

**Project Leader:** Reardon

**Objectives:** To determine the species (strains) of ectomycorrhizae (ECM) fungi and in combination with other treatments for suppressing Cylindrocladium root disease and promoting seedling growth.

**Cooperators:**

Yun Wu  
Michigan Technological  
University

Margaret Gale  
Michigan Technological  
University

Martin MacKenzie  
NA-FHP

Alan Iskra  
NA-FHP

**Accomplishments:**

- o Strains of ectomycorrhizae from State nurseries in Pennsylvania were evaluated in the laboratory and greenhouse as a control of Cylindrocladium .
- o Strains of microorganisms from State nurseries in Pennsylvania were selected through pairing with Cylindrocladium.

**Final Product and Delivery Date:**

Biological control option for managing Cylindrocladium root disease. March 1998.

**Project:** III.5.i Establish Parasites of the Mealybug Oracella acuta in the People's Republic of China

**Project Leader:** Reardon

**Objectives:** 1) To establish and/or identify dense populations of Oracella acuta in pine plantations in Georgia for collecting natural enemies; 2) to identify the major parasites that may be used in a classical biological control program in the People's Republic of China (PRC); and 3) to arrange to collect and ship natural enemies to the PRC for establishment in quarantine and subsequent release into the field.

**Cooperators:**

Wayne Berisford  
Univ. of Georgia

Gary DeBarr  
Southern Research  
Station

Stephen Clarke  
R8-FHP

Chen Mu Rong  
Guangdong Provincial Pest  
Control Station

Wu Jian  
Chinese Academy of  
Forestry, Research Inst.  
of Forest Protection

Sun Jianghua  
Northeastern  
Forestry  
Univ., Harbin, PRC

**Accomplishments:**

- o Parasites collected in U.S. and shipped to PRC for field release and laboratory colony production
- o Several cooperators from PRC as well as U.S. toured parasite collection sites as well as laboratory rearing and release sites, respectively.

**Final Product and Delivery Date:**

Establishment of parasites of the mealybug in the PRC. December 1998.

**Project:** III.5.j Establish Natural Enemies of Cypress Aphid in Kenya

**Project Leader:** Reardon

**Objectives:** 1) To locate, collect, and rear parasites and invertebrate predators of the Cypress aphid from populations in North America, Mexico, India, and Pakistan; and 2) to ship these parasites and invertebrate predators to a quarantine facility in England for eventual release in Kenya.

**Cooperators:**

Daniel Kucera  
NA-FHP

Joseph Mwangi  
Kenya FHMC

Sean Murphy  
Intern'l Inst. of  
Biological Control

Robert Averill  
R2-FHP

Susan Johnson  
R2-FHP

Denny Ward  
R8-FHP

**Accomplishments:**

- o Project initiated in 1991 as cooperative effort Northeastern Area State and Private Forestry FHP (Kucera) and IIBC (Murphy).
- o Parasites collected in Colorado in 1994 and shipped to quarantine facility in England, but did not become established in Kenya.
- o Several species of parasites collected in southern England and northern France did become established in Kenya.

**Final Product and Delivery Date:**

Establish natural enemies of Cypress aphid in Kenya. September 1997.



**Project:** III.5.k Develop an Integrated Management System for Cogongrass in Southern Pine Forest Ecosystems

**Project Leader:** Reardon

**Objectives:** 1) To integrate presently available control strategies for the suppression of cogongrass, including fire, mowing, disking, and herbicide; 2) to develop criteria for selection and evaluation of appropriate biological control agents; 3) to integrate conventional control methods with the most successful biological control approaches; 4) to recommend long-term forest management strategies that are compatible with maintaining desirable plant communities.

**Cooperators:**

Ed Barnard Florida Dept. of Agriculture	Karl Siderits USDA-FS, Nat'l Forests in Florida	Gary DeBarr Southern Research Station
James Brown R8-FHP	Donn Shilling Univ. of Florida	Ernest Delfosse USDA-ARS
Jim Meeker Florida Dept. of Agriculture	Andrea Christian Withlacoochee State Forest	

**Accomplishments:**

- o Series of plots established at Withlacoochee State Forest
- o Initial evaluations of a native fungus on cogongrass in the greenhouse.

**Final Product and Delivery Date:**

An effective integrated management system for cogongrass in southern pine forest ecosystems. December 2001.

**Project:** III.5.1 Biological Control of Weeds Workshop

**Project Leader:** Reardon

**Objectives:** To provide a forum for coordination and transfer of technology for the biological control of weeds.

**Cooperators:**

George Markin  
Intermountain Forest  
and Range Experiment Station

Ernest Delfosse  
USDA-ARS

Roy VanDriesche  
Univ. of Mass.

Ray Carruthers  
USDA-ARS

Gary Johnston  
USDI Nat'l Park Service

Dave Thomas  
USDA-FS, WO-FHP

Chuck Parker  
USDI Geological Service

**Accomplishments:**

- o Arrangements completed for informal conference "biological control in natural areas" to be included as part of the Entomological Society of America's nation meeting. Conference co-sponsored by USDA Forest Service FHTET, USDI National Park Service and USDI Geologic Survey. FHTET will publish the proceedings for this conference.
- o Arrangements nearing completion for the Interagency Noxious Weed Symposium sponsored by Oregon Dept. of Agriculture. FHTET will publish the proceedings for this symposium.

**Final Product and Delivery Date:**

Proceedings of two workshops on biological control. December 1997.

**Project:** III.5.m Dyer's Woad Control Demonstration

**Project Leader:** Reardon (initiated by Barry)

**Objectives:** The focus of the project is being redirected from emphasis on aerial application of the fungus, Puccinia thlaspeos, to control large areas infested with Dyer's woad to more basic biology and life history evaluations of the fungus and Dyer's woad enabling inoculative releases of the fungus.

**Cooperators:**

Sherman Thompson  
Utah State Univ.

Brad Kropp  
Utah State Univ.

Dave Baumgartner  
R4-FHP

John Guyon  
R4-FHP

Wayne Padgett  
Wasatch-Cache NF

Jed Dewey  
R1-FHP

Dave Thomas  
WO-FHP

The State of Utah  
Dept. of Transportation

**Accomplishments:**

- o Dose response evaluations conducted in the field and laboratory ongoing.
- o Laboratory production techniques evaluated.

**Final Product and Delivery Date:**

A system for dispensing fungus to control Dyer's woad. December 2000.

**Project:** III.5.n Vegetation Management Options for Enhancing Ecosystem Health

**Project Leader:** Reardon (initiated by Barry)

**Objectives:** To demonstrate and evaluate herbicide ground treatment methods for use in supporting species diversity and productivity in middle-aged Douglas-fir forests.

**Cooperators:**

Michael Newton  
Oregon State Univ.

Dave Thomas  
WO-FHP

Max Ollieu  
R6-FHP

**Accomplishments:**

- o Continued collection of data from control and herbicide treated plots.

**Final Product and Delivery Date:**

Procedures and recommendations for effective ground application of herbicides enhancing understory vegetation under thinned stands of Douglas-fir in the Pacific Northwest. December 1998.



**Project:** III.6.a Impacts of Bacillus thuringiensis and Gypsy Moth Defoliation

**Project Leader:** Stein/Reardon

**Objective:** To determine the potential long-term impacts of selected insecticides and defoliation on selected non-target terrestrial arthropods, salamanders, and birds associated with broadleaved forests.

**Cooperators:**

Linda Butler  
West Virginia Univ.

Tom Pauley  
Marshall Univ.

Robert Cooper  
Univ. of Georgia

Gary Bustamante  
USDA-FS, Monogahela NF

Jeff Witcosky  
USDA-FS, George Washington NF

Ann Hajek  
Cornell Univ.

**Accomplishments:**

This is the third year of collecting baseline population information on the distribution, abundance, physiology, and productivity of over 550 species of arthropods (herbivores, predators, and parasites), 100 species of spiders, four species of amphibians, and five species of birds. Field data is still being entered into a data base. Preliminary information has not yet been summarized. Preparation of NEPA documents and Environmental Assessments were completed. Treatments of Bacillus thuringiensis var. kurstaki and Gypchek were applied to plots located on the George Washington and the Monongahela National Forests in May. A peer review of this study was completed in June with the recommendation that one of the objectives be changed from "Develop recommendations for Federal and State Cooperative Suppression, eradication, and slow-the-spread projects to minimize impacts to nontarget organisms" to "Filling in data gaps to support use of these insecticides for Federal and State...organisms."

**Final Product and Delivery Date:**

Provide documentation concerning non-target impacts; if necessary, minimize these impacts by modifying selected aspects of the Federal and State Cooperative Gypsy Moth Suppression program. December 2001.

**Project:** III.6.b Development and Application of Semiochemicals for Protection of Pine Seed Crops

**Project Leader:** Stein/Reardon

**Objective:** To develop attractants/repellents to determine the impact of Conophthorus behavioral chemicals for protection of pine seed crops, and to assess the non-target effects on other species of cone beetles and bark beetle predators.

**Cooperators:**

Gary DeBarr  
USDA-FS, Southern  
Research Station

Arturo Del Rio Mora  
INIFAP, Mexico

Peter DeGroot  
Forestry Canada

Nancy Rappaport  
USDA-FS, PSW Research  
Station

Larry Barber  
R8-FHP

Larry Binder  
R5, Tahoe RD

**Accomplishments:**

During this first year, plots were established to test semiochemicals for Conophthorus beetles infesting high value ponderosa pine in California, eastern white pine in North Carolina, red pine in the province of Ontario, Canada, and Pinus teocote and Pinus pseudostrobus in the province of Uruapan, Mexico. Female beetle pheromones were tested alone and in combination with other compounds. Preliminary information indicates that certain compounds both synergize and inhibit behavior associated with these beetle produced pheromones.

**Final Product and Delivery Date:**

Results from this study will provide semiochemicals to control cone beetles in seed orchards. December 1999.

**Project:** III.6.c Development of Pheromones for Cone Worm Population Monitoring and Control

**Project Leader:** Stein/Reardon

**Objective:** To determine the most efficacious formulations of Dioryctria pheromones in order to control cone worm populations with minimal impacts on non-target insects.

**Cooperators:**

Gary Grant  
Forestry Canada

Gerldine Roux  
Univ. of Orleans, France

Nancy Rappaport  
USDA-FS, PNW Research  
Station

Laura Merrill  
R5-FHP

Charles Frank  
R5-TM

Sandra Kegley  
R5-FHP

Nancy Campbell  
R5-FHP

**Accomplishments:**

Phero-Tech Delta traps baited with four promising pheromone blends were deployed in a bi-weekly schedule (May-October) at four sites that represented two pine species suffering substantial seed losses to cone worms (Ponderosa pine: Chico Genetic Resource Program, USDA Forest Service, Pacific SW Region, Chico, California; Whitebark pine: Ball Mountain, Goosenest Ranger District, Klamath National Forest, Yreka, California; Whitebark pine: Gisborne Mountain, Priest Lake Ranger District, Idaho Panhandle National Forests). Insects were conserved for morphological identification and DNA sequencing.

**Final Product and Delivery Date:**

Results from this study will provide tools for monitoring and control of cone worms in seed orchards. December 1999.

**Project:** III.6.d Evaluation of Prescribed Burning as a Viable Management Tool for Longleaf Pine

**Project Leader:** Stein

**Objective:** To determine the impacts of fire on mycorrhizae, root pathogenic fungi, and root-feeding beetles on longleaf pine.

**Cooperators:**

William Otrosina  
USDA-FS, Southern  
Research Station  
Athens, GA

Susana Sung  
USDA-FS, Southern  
Research Station  
Athens, GA

Stan Zarnoch  
USDA-FS, Southern  
Research Station  
Asheville, NC

Wayne Berisford  
Univ. of Georgia

Nolan Hess  
R8-FHP

Charles Walkinshaw  
USDA-FS, ret.

Kier Klepzig  
USDA-FS, Southern  
Research Station  
Pineville, LA

**Accomplishemnts:**

Sampling was begun in March 1997, after prescribed burning treatments were completed at the Savannah River Site, New Ellenton, SC, core samples from established sub-plot trees were taken of the residual litter and soil to a depth of 8.0 cm. Samples were partitioned into organic matter fractions and soil. Roots from these cores were separated and analyzed for ergosterol content. To date, no differences have been detected in ergosterol content due to treatment; however, a seasonal trend is evident. Insect trapping studies on treated sites revealed a high proportion of Leptographium isolates carried by Dendroctonus terebrans and Hylastes salebrosus, the two most commonly trapped beetles. The identification of the potentially pathogenic fungi they carry, and the role these beetles play will be the subject of further investigation during 1998.

The burning study carried out in Louisiana revealed a possible new occurrence of a Leptographium species heretofore not known on roots of trees in the Southeastern US. Information of the identify of this fungus is being determined at this time. Plots were not established in Florida in 1997 due to unfavorably dry conditions extending late into the burning season. District forest managers postponed the burn treatment until FY 1998.

**Final Product and Delivery Date:**

Information for proactive measures needed for successful attainment of management objectives for longleaf pine. January 2000.



**Project:** III.6.e Evaluation of Forest Management Strategies on Ponderosa Pine Productivity

**Project Leader:** Stein

**Objective:** Determine the impact of site disturbances on soil invertebrates and mycorrhizae as indicators of soil health and productivity.

**Cooperators:**

Robert Powers  
USDA-FS, PSW  
Research Station

Matt Busse  
USDA-FS, PSW  
Research Station

Nancy Rappaport  
USDA-FS, PSW  
Research Station

Gregg DeNitto  
USDA-FS, R5-FHP

Dave Shultz  
USDA-FS, R5-FHP

**Accomplishments:**

Sampling transects were installed at two Garden of Eden sites, Whitmore and Feather Falls, in the Sierra Nevada range of California. Soil moisture and soil temperature were measured at these sites three times during the season (spring, mid-summer, and fall). Pitfall traps were installed, and laboratory facilities were constructed to extract soil arthropods from soil cores and sifted litter samples. Soil cores, sifted litter samples, and pitfall trap samples were taken in the fall at each replicate of the following treatments: herbicide, herbicide + thinning, herbicide + fertilizer, and herbicide + thinning + fertilizer. In addition, fungal hyphal length and biomass, total bacterial biomass, total and viable bacterial numbers, total microbial biomass, and total soil respiration measurements were taken three times this year at each site.

**Final Product and Due Date:**

Results will demonstrate the effects of forest management practices on forest soil productivity, and will also provide methodology for similar studies conducted at other sites. December 1999.

**Project:** III.6.f Archive of Images of Selected Forest Lepidoptera

**Project Leader:** Reardon/Stein

**Objectives:** To expand the national archive CD-ROM release of full-color digital forest-related insects, diseases, and management practices images.

**Cooperators:**

Keith Douce  
University of Georgia

David Moorhead  
University of Georgia

Wes Nettleton  
R8-FHP

David Wagner  
University of Connecticut

**Accomplishments:**

- o Preliminary list of rare and endangered species associated with forested ecosystems is being prepared. From this list approximately 40 species will be selected and included on the first CD-ROM.
- o Preliminary list of forest geometrids is being prepared. From this list approximately 70 species will be selected and publishing as a field guide.

**Final Product and Delivery Date:**

Field guide to common forest geometrids and CD-ROM of Rare and Endangered lepidopteran species in forested habitats. December 1998.

**Project:** III.6.g Improve the Biological Basis for Gypchek Use on Monongahela NF.

**Project Leader:** Stein

**Objective:** Determine the natural history of the non-target moth, Brachionycha borealis (Smith) (Lepidoptera: Noctuidae), in West Virginia to establish whether or not its larval phenology and food plant place is at risk through exposure to gypsy moth bacterial spray. This boreal species, listed in West Virginia as a Species of Special Concern, has influenced Gypchek use by the Monongahela NF to suppress gypsy moth despite few details about its biology.

**Cooperators:**

John Rawlins	Robert Acciavatti
Carnegie Museum of	NA-FHP
Natural History	

**Accomplishments:**

Study plots were established in 1997. Preliminary information suggests that this moth has a significant microhabitat association with Vaccinium spp. All species of Lepidoptera collected on the plots were reared, photographed, and preserved in critical immature stages. This biological information will contribute to a publication covering all eastern Nearctic Psaphidinae. Field work in 1998 will focus on capture of adult female Brachionycha borealis and rearing larval instars.

**Final Product and Delivery Date:**

Document habitat occurrence, host plants, and larval phenology for Brachionycha borealis in West Virginia in order to prepare guidelines on Gypchek use in Monongahela NF spray blocks. These guidelines are based on: 1) the probability of this moth's occurrence by plant associations; 2) the likely exposure of feeding larvae to bacterial insecticide spray. Delivery of report December 1998.

NOTE: Project III.6.g is not in the Plan of Work for FY97 and should be considered an additional task.

**Project:** III.7.a Management of NAPIAP

**Project Leader:** G.Smith

**Objective:** To administer the Forest Service segment of the National Agricultural Pesticide Impact Assessment Program (NAPIAP)

**Cooperators:**

Region/Area	Patrice Janiga	Judy Adams
NAPIAP Coordinators	USDA-FS, FHTET-FC	USDA-FS, FHTET-FC

**Accomplishments:**

FHTET-Morgantown compiled and distributed 1996 project status/final reports. FHTET-M coordinated with WO-FHP to establish priority data needs for FY97 and developed and sent out the call letter for the FY97 project cycle. A review panel was established and rated the 1997 proposals and provided the ratings and recommendations to the Director, FHTET-M, for final approval and funding. In FY97, we awarded funding to 21 pesticide-related study proposals. We worked with FHTET-Fort Collins toward the development of a unified database for FHTET-managed programs, including NAPIAP and STDP (Project II.3.d). FHTET-M also developed all related correspondence, maintained contact with Regional, Area, and IITF program coordinators to monitor progress, and reported program accomplishments annually. The FHTET-Morgantown Director serves as the Agency Representative to the USDA-NAPIAP Group. We improved coordination and understanding of FS-NAPIAP program with USDA and university colleagues through presentations to national and regional USDA-NAPIAP meetings.

**Final Products and Delivery Dates:**

Call letter for FY97 proposals	August 1996
Establish proposal review panel	December 1996
Recommendations to Director, FHTET-M	January 1997
Prepare award letters	February 1997
Insert project records in database	Ongoing
FY96 accomplishment reports	October 1996



**Project:** III.8.a. Management of Pesticide Registration Programs

**Project Leader:** Stein

**Objectives:** 1) To administer the FS and FHP pesticide programs in terms of coordinating data acquisition in support of registration and re-registration of biochemical and microbial pesticides of interest to the FS; and 2) to monitor registration status of these pesticides and coordinate with Inter-Regional 4 Group (IR-4) on minor use pesticides of interest to FS.

**Cooperators:**

FHP-WO, FHP Regional/Area Pesticide Coordinators, other federal, state, university, and private industry representatives.

**Accomplishments:**

Work on contracts, data submission, registration and re-registration progressed for the following biological pesticides: 1) Nucleopolyhedrosis viruses of the gypsy moth and Douglas-fir tussock moth. Data results were obtained for two additional toxicity studies for Gypchek. The results will be used to bridge product specific information, lower the toxicity category, and modify the restrictive language for registration of both Gypchek and TM-Biocontrol. 2) Registration for the bark beetle anti-aggregation pheromone MCH is progressing, but still pending. All of the appropriate nontarget studies have been accepted. Additional risk assessment information will not be required. EPA is now in the process of conducting a scientific review of all the basic toxicity studies. 3) Five contracts were successfully negotiated to determine human health effects of the bark beetle repellent 4-allylanisole.

Two Pesticide Regulation Courses involving the law, science, strategies and requirements of antimicrobial and biological pesticide registration were completed.

**Final Products and Delivery Dates:**

Coordinate data acquisition for reregistration of Gypchek and TM Biocontrol-1	January 1998
Facilitate new data studies, produce new label and complete registration package for MCH	March 1998
Implement contracts for data studies of 4-allylanisole	August 1998
Review registration status of pesticides currently used in forestry	Ongoing
Attend Biopesticide Regulation Workshops	Ongoing
Improve communications with EPA and facilitate	Ongoing
Forest Service participation in the registration process	Ongoing

## APPENDIX A: Acronyms and Abbreviations

APHIS	Animal and Plant Health Inspection Service
ARS	Agricultural Research Service
<u>Btk</u>	<u>Bacillus thuringiensis</u> var. <u>kurstaki</u>
CABI	Center for Agriculture and Business, Inc.
DFTM	Douglas-fir tussock moth
DSS	Decision Support System
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FHP	Forest Health Protection
FHTET	Forest Health Technology Enterprise Team
FHTET - FC	Forest Health Technology Enterprise Team, Fort Collins
FHTET-M	Forest Health Technology Enterprise Team, Morgantown
FRI	Forest Research Institute
FS	Forest Service
FTP	File transfer protocol
FMSC	Forest Management Service Center
FSCBG	Forest Service Cramer-Barry-Grim Aerial Spray Model
GIS	Geographic information system
HTML	Hyper-Text Markup Language
IIBC	International Institute of Biological Control
INFORMS	Integrated Forest Management System
MTDC	Missoula Technology Development Center
NA	Northeastern Area
NAPIAP	National Agricultural Pesticide Impact Assessment Program
NBS	National Biological Survey
NC	Northcentral Forest Experiment Station
NEFES	Northeastern Forest Experiment Station
NEPA	National Environmental Policy Act
NF	National Forest
NPV	Nucleopolyhedrosis virus
NRIS	National Resource Information Systems
NWS	National Weather Service
PDF	Portable Document Format
PNW	Pacific Northwest Forest and Range Experiment Station
POW	Program of Work
PRC	the People's Republic of China
PTIPS	Pest Trend Impact Plot System
PURS	Pesticide Use Reporting System
RSAC	Remote Sensing Applications Center
SPB	Southern Pine Beetle
STDP	Special Technology Development Program
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
WO	Washington Office
WWPB	Westwide Pine Beetle
WFHI	Western Forest Health Initiative
WWW	World Wide Web

## APPENDIX B: Publications

- Adams, Judy; Williams-Cipriani, Julie; Marston, Jonathan; Platz, Renee. 1996. PTIPS database applications user's guide and reference manual: Pest-trend-impact plot system version 3.00.11.96. FHTET 96-33. Fort Collins, CO: USDA Forest Service, Forest Health Protection, Forest Health Technology Enterprise Team. 290p.
- Ammons, R.; Thistle H.; Barry, J. 1996. Optimized pesticide application. 9634-2831-MTDC. Missoula, MT:USDA Forest Service, Missoula Technology Development Center. 16p.
- Barry, J.W. 1996. Report of the national pesticide-use management training course, March 16-30, 1994, Marana, AZ. FHTET 96-27. Davis, CA: USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 149p.
- Barry, J.W.; Skyler, P.J.; Whitmire, N. 1995. FY 95 accomplishments, Forest Health Technology Enterprise Team-Davis. FPM 96-2. USDA Forest Service, Forest Health Technology Enterprise Team-Davis, Davis, CA. 20p.
- Barry, J.W.; Teske, M.E.; Thistle, H.W.; Skyler, P.J.; MacNichol, A.Z. 1996. Spray deposition and drift in orchards. ASAE Paper NO. AA96-006. St. Joseph, MI: American Society of Agricultural Engineers. 34p.
- Barry, John W.; Skyler, Patricia. 1996. Sixth report: National spray model and application technology steering committee. FHTET 96-14. Davis, CA: USDA Forest Service, Forest Health Technology Enterprise Team. 93p.
- Bilanin, A.J.; Teske, M.E.; Geyer, R.G. 1996. Interaction of spray aircraft wake with convective surface winds in hilly terrain. FHTET 96-26. Davis, CA: USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 124p.
- Bunch, J., Williams, S. 1997. INFORMS-Decision Protocol: Meeting the changing needs of forest resource planning. FHTET 97-09. Fort Collins, CO: USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 14p.
- Carruthers, R.; Petroff, J., eds. 1997. Proceedings of the invitational workshop on USDA activities in biological control. 8-11 October 1996. Riverdale, MD and Washington, DC. Washington, DC: USDA Agricultural Research Service. 120p.
- FHTET 97-12 Forest Health Technology Enterprise Team. 1997. Special Technology Development Program: Production function handbook for new project proposals. Fort Collins, CO: USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 27p.
- FHTET 97-17 Forest Health Technology Enterprise Team. 1997. Insect and Pathogen Models. Fort Collins, CO: USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 2p.
- FHTET 97-18 Forest Health Technology Enterprise Team. 1997. Quantitative Methods. Fort Collins, CO: USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 2p.



FHTET 97-19 Forest Health Technology Enterprise Team. 1997. Decision Support Systems. Fort Collins, CO:USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 2p.

FHTET 97-20 Forest Health Technology Enterprise Team. 1997. Information Distribution. Fort Collins, CO:USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 2p.

FHTET 97-22 Forest Health Technology Enterprise Team. 1997. Biopesticides. Fort Collins, CO:USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 2p.

FHTET 97-23 Forest Health Technology Enterprise Team. 1997. Biological Controls. Fort Collins, CO:USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 2p.

FHTET 97-24 Forest Health Technology Enterprise Team. 1997. Nontarget Impacts. Fort Collins, CO:USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 2p.

FHTET 97-25 Forest Health Technology Enterprise Team. 1997. Management of Pesticides. Fort Collins, CO:USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 2p.

FHTET 97-26 Forest Health Technology Enterprise Team. 1997. Equipment and Application Technologies. Fort Collins, CO:USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 2p.

Frank, J.; Foltz, J. 1997. Classical biological control of pest insects of trees in the southern United States: A review and recommendations. FHTET 96-20. Morgantown, WV:USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 78p.

Gebhardt, A.E.; Holmes, S.; Reardon, R.C. 1997. Bioinsecticides for forest and shade tree defoliation: Annotated bibliography of nontarget impacts. FHTET-97-05. USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 183p.

Ghent, J.H.; Twardus, D.B.; Thomas, S.J.; Teske, M.E. 1996. GypsES: The gypsy moth decision support system. ASAE Paper No. AA96-005. St. Joseph, MI: American Society of Agricultural Engineers. 6p.

Kilroy, B.; Rising, D.; Thistle, H. 1996. Single-tree spray application project. Final Report 9634-2838-MTDC. Missoula, MT: USDA Forest Service, Missoula Technology & Development Center. 14p.

Kirk, I.W.; Tom, H.H. 1996. Precision GPS flow control for aerial spray applications. ASAE Paper No. A96-009 St. Joseph, MI: American Society of Agricultural Engineers. 7p.

Leonhardt, B.; Mastro, V.; Leonard, D.; McLane, W.; Reardon, R.; Thrope, K. 1996. Control of low-density gypsy moth populations by mating disruption with pheromone. Journal of Chemical Ecology. 22:1255-1272.

Liebhold, A.; Gottschalk, K.; Luzaden, E.; Mason, D.; Bush, R.; Twardus, D. 1997. Gypsy moth in the United States: An atlas. General Technical Report NE-233. Morgantown, WV: USDA Forest Service, Northeastern Forest Experiment Station. 36p.



- Liebold, A.; Luzader, E.; Reardon, R.; Bullard, A.; Roberts, A.; Raubin, W.; DeLost, S.; Spears, B. 1996. Use of geographic information systems to evaluate regional treatment effects in a gypsy moth management program. *Journal of Economic Entomology*. 89:1193-1203.
- McCullough, D.; Sadof, C. 1995. Pine Shoot beetle compliance program for Christmas trees. Michigan State University Extension Bulletin E-2615. East Lansing, MI: Michigan State University. 15p.
- McClure, M.; Salom, S.; Shields, K. 1997. Hemlock woolly adelgid. FHTET 96-35. Morgantown, WV: USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 14p.
- Onken, A.; Reardon, R. 1995. The effects of diflubenzuron on nontargets: Update no.1: A bibliography. FPM-NC-02-95. USDA Forest Service, Forest Health Technology Enterprise Team-Morgantown, Morgantown, WV. 125p.
- Riffe, M.W.; Williams, S.B.; Perisho, R.J.; Twombly, E.D. 1997. INFORMS: User's Guide. FHTET 97-03. Fort Collins, CO: USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 96p.
- Reardon, R.C. 1997. Appalachian Integrated Pest Management Gypsy Moth Project: Summary and bibliography. NA-TP-05-96. Morgantown, WV: USDA Forest Service, Northeastern Area. 12 p.
- Reardon, R.C. 1997. National center of forest health management: Bibliography. NA-TP-06-96. USDA Forest Service, State and Private Forestry, Forest Health Protection. 9p.
- Reardon, R.C.; Podgewaite, J.; Zerillo, R. 1996. Gypchek: The gypsy moth nucleopolyhedrosis virus product. FHTET 96-16. Morgantown, WV: U.S. Department of Agriculture, Forest Service, Forest health Technology Enterprise Team. 28p.
- Rosenberger, Randall S.; Peterson, George L. 1997. Use of paired comparison in valuing nonmarket forest resources. Paper presented at Southern Forest Economics Workshop (SOFEW). 1997 March 19-21; Little Rock, AR. Proceedings in print.
- Rosenberger, Randall S.; Smith, Eric L. 1996. Nonmarket economic impacts of forest insect pests: A review of the literature. MS 96-131. San Francisco, CA: USDA Forest Service, Pacific Southwest Region, Forest Pest Management. 80p.
- Rosenberger, Randall S.; Smith, Eric L.; Gonzalez-Caban, Armando. 1997. Using multiple valuation methods for public involvement in management decisions. Paper presented at Southern Forest Economics Workshop (SOFEW). 1997 March 19-21; Little Rock, AR. Proceedings in print.
- Shewmaker, Kaye; Mullen, J.D.; Williams, Stephen; Riffe, Mark; Marston, Jonathon. INFORMS Installation Guide. FHTET 97-07. Fort Collins, CO: USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 93p.
- Skyler, Patricia, Ed. 1996. FSCBG model technology transfer letter. No.7, September, 1996. Davis, CA: USDA Forest Service, Forest Health Technology Enterprise Team. 15p.



Teck, Ricahrd; Moeur, Melinda; Eav, Bov. Forecasting ecosystems with the Forest Vegetation Simulator. Journal of Forestry. 94:12(7-10)

Teske, M.E. 1995. FSCBG/RT: Real-time model subroutines for spray cloud prediction. FPM 95-9 (C.D.I. Technical Note 94-20). Prepared under Contract No.53-0340-4-00009 by Continuum Dynamics, Inc., for USDA Forest Service, Forest Health Technology Enterprise Team-Davis, Davis, CA. 20p.

Teske, M.E. 1995. *Bacillus thuringiensis* drift deposits on foliage and physical samplers-a summary of the Utah drift studies 1991-1993. FPM 95-18 (C.D.I. Technical Memo 95-11). Prepared under Contract No.53-0340-4-00153 by Coninuum Dynamics, Inc., for USDA Forest Service, Forest Health Technology Enterprise Team-Davis, Davis, CA. 20p.

Teske, M.E. 1995. COMBINE: A software program which generates multiple flight line results from a single flight line. FPM 95-20 Prepared under Contract No.53-0340-4-00153 by Coninuum Dynamics, Inc., for USDA Forest Service, Forest Health Technology Enterprise Team-Davis, Davis, CA. 20p.

Teske, M.E. 1996. The status of FSCBG and related model developments: A 1996 update. FHTET 96-17 (C.D.I. Technical Memo 96-12). Prepared by Continuum Dynamics, Inc., under Contract No. 53-0343-1-00153 for USDA Forest Service, Forest Health Technology Enterprise Team-Davis, Davis, CA. 8p.

Teske, M.E. 1996. A resource bibliography for the USDA Forest Service Cramer-Barry-Grim (FSCBG) aerial spray model. FHTET 96-29. Davis, CA: USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 22p.

Teske, M.E. 1996. Evaluation of the FSCBG aerial spray model's near-wake sensitivity to selected input parameters. FHTET 96-30. Davis, CA: USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 84p.

Teske, M.E.; Curbishley, T.; MacNichol, A.Z. 1995. FSCBG version 4.35: One-on-one training notes. FPM 95-19. Prepared under Contract No.53-0343-4-00009 by Continuum Dynamics, Inc., for USDA Forest Service, Forest Health Technology Enterprise Team-Davis, Davis, CA. 7p.

Teske, M.E.; Kaufman, A.E.; George, C.W.; Grim, B.S.; Barry, J.W. 1995. Field measurements of helicopter rotor wash in hover and forward flight. Paper presneted at the American Helicopter Society Aeromechanics Specialist Conference, October 11-13, Fairfield County, CT. 8p.

Teske, M.E.; MacNichol, A.Z. 1996. Biological/Insecticide dose-response data collected for FSCBG and GypsES spray advisor models. FHTET 96-22. Davis, CA: USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 73p.

Thistle, H.W. 1996. MTDC/FHP technology development program: FY96 accomplishment report. FHTET 96-32. Davis, CA: USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 17p.

Thistle, Harold W.; Barry, John W. 1996. Meterology and aerial spraying of forests: Status of on-going work in USDA Forest Service technology and development. In: Proceedings fo the 1995 Society of American Foresters convention. 1995 October 28-November 1; Portland, ME. Bethesda, MD: Society of American Foresters.



USDA Forest Service, Forest health Protection, Forest Health Technology Enterprise Team. 1996 Accomplishment Report. FHTET 96-28. Fort Collins, Colorado: USDA Forest Service, Forest Health Protection, Forest Health Technology Enterprise Team. 108p.

Van Driesche, R.; Healy, S.; Reardon, R. 1997. Biological control of arthropod pests of the northeastern and north central forests in the United States: A review and recommendations. FHTET 96-19. Morgantown, WV: USDA Forest Service, State and Private Forestry, Forest Health Protection, Forest Health Technology Enterprise Team. 257p.

Wagner, D.; Henry, J.; Peacock, J.; McManus, M.; and Reardon, R. 1995. Common caterpillars of eastern deciduous forests. FHM-NC-04-95. USDA Forest Service, Forest Health Technology Enterprise Team-Morgantown, Morgantown, WV. 31p.

Williams, Stephen B.; Perisho, Ron; Holtfrerich, David R. 1995. INFORMS R-8: The utility of rulebase technology in a decision support system. Abstract of poster display presented at Conference of Society of American Foresters, Portland, ME: 28 October-1 November, 1995. 2p.

Williams, Stephen B. Thompson, Matt; Roschke, David J. 1996. Gypsy moth expert system (GypsES) review. FHTET 96-24. Fort Collins, CO:USDA Forest Service, Forest Health Technology Enterprise Team. 120p.



1022458490

Disclaimer: The use of trade names and identification of firms or corporations is for the convenience of the reader; such use does not constitute an official endorsement or approval by the United State Government of any product or service to the exclusion of others that may be suitable.

This information is the sole property of the Government with unlimited rights in the usage thereof and cannot be copyrighted.



NATIONAL AGRICULTURAL LIBRARY



1022458490